

Open Research Online

The Open University's repository of research publications and other research outputs

The development of alternative energy sources with particular reference to wind farms

Thesis

How to cite:

Midgley, Keith H (2009). The development of alternative energy sources with particular reference to wind farms. PhD thesis The Open University.

For guidance on citations see [FAQs](#).

© 2009



<https://creativecommons.org/licenses/by-nc-nd/4.0/>

Version: Version of Record

Link(s) to article on publisher's website:

<http://dx.doi.org/doi:10.21954/ou.ro.00010026>

Copyright and Moral Rights for the articles on this site are retained by the individual authors and/or other copyright owners. For more information on Open Research Online's data [policy](#) on reuse of materials please consult the policies page.

oro.open.ac.uk

UNRESTRICTED

THE DEVELOPMENT OF ALTERNATIVE ENERGY SOURCES
WITH PARTICULAR REFERENCE TO WIND FARMS

BY

KEITH H. W. MIDGLEY BA (OU) MSc (SAL)

A Thesis presented for the Degree of Master of Philosophy
at The Open University

Energy and Environment Research Unit

The Open University

2006

Submitted : 6 Nov. 2006
Date of award : 20 March 2009

ProQuest Number: 13917237

All rights reserved

INFORMATION TO ALL USERS

The quality of this reproduction is dependent upon the quality of the copy submitted.

In the unlikely event that the author did not send a complete manuscript and there are missing pages, these will be noted. Also, if material had to be removed, a note will indicate the deletion.



ProQuest 13917237

Published by ProQuest LLC (2019). Copyright of the Dissertation is held by the Author.

All rights reserved.

This work is protected against unauthorized copying under Title 17, United States Code
Microform Edition © ProQuest LLC.

ProQuest LLC.
789 East Eisenhower Parkway
P.O. Box 1346
Ann Arbor, MI 48106 – 1346

ACKNOWLEDGEMENTS

I am indebted to Prof. David Elliott my Internal Supervisor who supported my original application to the Open University and who continued to encourage me throughout several years of research.

I am also grateful to Dr. D.W. Swift (Bill), my External Supervisor whose encouragement and advice on approaches to research throughout the whole project was invaluable, this despite having to overcome a number of unforeseen personal problems. Best wishes for the future Bill.

I would also like to thank my wife Jean for her assistance and patience throughout the whole of this undertaking.

CONTENTS

<u>Introduction</u>	Page i- iii
<u>Section 1 A study of large scale wind generation schemes -- Opportunities and challenges.</u>	
Forward	Page 1
<u>Section 2 The long term future of energy supplies in the United Kingdom, as outlined in government policies.</u>	
<i>i. Environmental challenges.</i>	<i>Page 6</i>
<i>ii. Energy diversity.</i>	<i>Page 8</i>
<i>iii. Development of an energy policy.</i>	<i>Page 13</i>
<i>iv Development of wind energy.</i>	<i>Page 15</i>
<i>v Renewable targets for Wales.</i>	<i>Page 16</i>
<i>vi The possible adverse effects of planning processes for renewables, in particular wind energy.</i>	<i>Page 18</i>
<i>vii Renewable Energy : Myths and Legends.</i>	<i>Page 21</i>
<i>viii The long term effects of wind energy on tourism.</i>	<i>Page 23</i>
<i>ix Conclusions to be drawn from an examination of two energy policies.</i>	<i>Page 26</i>
<i>x Offshore wind farms--- the future for renewables ?</i>	<i>Page 28</i>
<u>Section 3 A review of the problems encountered in obtaining planning permission for wind farms in N.Wales</u>	<i>Page 34</i>
<i>i The possible effects of physical and/or visual impacts</i>	<i>Page 35</i>
<i>ii A view of the possible economic benefits from renewable energy schemes</i>	<i>Page 42</i>

iii	<i>Renewable energy and/or improved energy conservation and efficiency ?</i>	<i>Page 44</i>
iv	<i>Who should have the final decisions on any wind farms, Cardiff or London ?</i>	<i>Page 47</i>
v	<i>Conclusions to be drawn from examinng the Pentrefoelas application.</i>	<i>Page 48</i>
vi	<i>What is required to produce a convincing Environmental Statement as part of a successful planning application?</i>	<i>Page 50</i>
vii	<i>Do the possible economic benefits outweigh the objections ?</i>	<i>Page 54</i>
viii	<i>Two examples of conflicting interests.</i>	<i>Page 58</i>
ix	<i>Are offshore wind farms free from planning difficulties?</i>	<i>Page 62</i>
x	<i>Summary of problems encountered with the proposed wind farm site at Pentrefoelas.</i>	<i>Page 64</i>
	<u>Section 4 A review of problems of and prospects for wind energy</u>	<i>Page 67</i>
i	<i>Characteristics of the UK wind resource. Long-term patterns and the relationship to electrical demands.</i>	<i>Page 72</i>
ii	<i>'The impact of intermittent generation on the UK electricity network.'-- two independent assessment reports, one German the other British.</i>	<i>Page 89</i>
iii	<i>Intermittency --what effect it can have on the shaping of public support for wind energy in the UK.</i>	<i>Page 97</i>
iv	<i>Balancing Renewables-- the need for alternative back-up energy systems.</i>	<i>Page 100</i>

<u>Section 5 The public perception of wind power</u>	Page 107
<i>i A closer look at some of the issues outlined in Sect 3.</i>	<i>Page 121</i>
<i>ii The Awel Aman Tawe Community Wind Farm Project.</i>	<i>Page 124</i>
<i>iii Climate Concern-The Welsh Consumer Council-2004.</i>	<i>Page 132</i>
<i>iv Understanding public perceptions of wind energy</i>	
<i>Three case studies of public attitudes towards wind</i>	
<i>farm developments.</i>	<i>Page 136</i>
<u>Section 6 A parting of the ways? How the Welsh Assembly's long</u>	
<u>term plan for renewable energy conflicts with the</u>	
<u>BWEA's commercial expectations for wind energy</u>	Page 149
<u>Section 7 Conclusions and Recommendations.</u>	
<i>i An overall summary</i>	<i>Page 162</i>
<i>ii Challenges.</i>	<i>Page 163</i>
<i>iii Population and economic growth</i>	<i>Page 163</i>
<i>iv Energy efficiency.</i>	<i>Page 164</i>
<i>v Energy sources.</i>	<i>Page 167</i>
<i>vi Comparisons with the Danish Wind Industry-often seen</i>	<i>Page 170</i>
<i>as the best example for the future of the UK wind industry</i>	
<i>vii The future of wind energy in North Wales.</i>	<i>Page 184</i>
<i>viii Final conclusions.</i>	<i>Page 189</i>
<u>Appendix 1</u>	Page 199
<u>Appendix 2</u>	Page 202

K. Midgley ID: U 3253947

An Abstract for a thesis presented for the Degree of Master of Philosophy entitled:-

‘The development of alternative energy sources with particular reference to wind farms.’

Numerous study groups and government white papers have concluded that a mixture of energy sources, including gas, clean-coal, alternative energy and possibly nuclear, will be required to meet future energy needs. Foremost amongst alternative energy sources is wind power, seen by the government as a cheap, carbon dioxide free energy source and one which has a history of successful development in Denmark and Germany. Wind power is currently the most developed renewable in the UK and because of its geographical position, Wales has been at the forefront of several new wind developments. This thesis outlines some of the stages in implementing a major wind farm development in Wales and how there is a correlation with developments in Denmark. It examines the challenges facing energy companies during the planning stage; foremost amongst these, the fact that some of the most favourable sites for wind penetration in the UK also coincide with a number of environmentally sensitive and protected areas and whether in the future, major new developments will be sited offshore.

Other challenges include the need to gain public approval for this form of alternative energy, through opinion polls, positive media coverage and most importantly a greater willingness by energy companies to engage the public in a sensible debate about the benefits of wind energy. It looks at, in some detail, the more recent concerns being expressed over the intermittency of

the wind resource and at more specific issues including local objections to visual intrusion in scenic areas and the well publicised promises for job creation. It examines the opposition to wind farm developments being mounted by well informed groups who question the viability of this form of alternative energy to play a significant part in the UK's future energy needs. In conclusion, it maintains that wind power, in the form of offshore wind farms, will *complement* other more traditional forms of energy sources, providing the case for wind power is not overstated.

INTRODUCTION

The impact of global warming, and the subsequent move towards achieving significant reductions in the amount of carbon dioxide in the atmosphere, has led to major changes in the way future energy needs will be met. The problem of how to reconcile the modern world's increasing demand for energy, whilst at the same time bring about a reduction in the dependence on fossil fuels to achieve this demand, has resulted in a renewed focus on alternative energy sources.

One such source which is expected to have a major impact on the problem is wind power. Since the early 1990s, wind power has become an important factor in the search for viable alternatives to fossil fuels. The recent rapid rise in the wind energy industry has however led to a number of challenges which may determine the direction and rate of progress towards targets outlined for alternative energy and in particular wind energy.

Whilst the whole of the UK was initially considered in this study, it was seen as more appropriate to examine the situation in Wales because it is ideally suited, geographically, for the siting of wind farms. There are already a small number of moderately sized wind farms in existence and the UK's first working off shore wind farm is situated off N. Wales.

The *aim* of this thesis is, therefore, to review a representative number of academic papers which, in themselves, outline the accepted theory and best practice necessary to sustain a viable wind energy programme in general and wind farm development in particular.

At the same time this thesis will examine the process by which actual developments are brought about, including the process of design and planning and some of the typical problems which may be encountered. It will examine in depth those wind farm developments in Wales which have either been successfully completed, or have encountered difficulties in the planning process which have led to eventual rejection. To this end it was necessary to look closely at a number of important issues, which together would indicate how future wind energy targets could be met.

The *methodology* involves examining:-

a) significant number of academic sources, research papers and reviews on the following subjects :-

i) The initial concept of wind power in the United Kingdom including those of Elliott (2001), Sharman (2002), Simpson (2004), Sinden (2005).

ii) Attitudes and the shaping of public support for wind energy examined by Walker (1995), Damborg (1998), Bibbings (2004), Devine-Wright (2004), Warren et al (2005), Bell et al (2005) and Ellis et al (2006).

iii) The possible effect of NIMBYism on public support, (Wolsink 2000), NATTA (2001), Devine-Wright (2004), Wolsink (2006).

iv) The importance of the concept of intermittency and its effect on eventual outcomes, Sinden (2005), Devine-Wright et al (2006), SDC (2005), UKERC (2006).

v) Wind planning outcomes, Ipsos (2003), Toke (2005).

vi) Technical and system costs, Strabc et al (2002), Carbon Trust (2004).

b) Government and Welsh Assembly policies on the long term future of energy supplies in the UK, with particular reference to wind energy. This information was obtained from various Energy Reviews, White Papers, Royal Commission Reports and the Welsh Economic Development Committee Reports.

c) Problems encountered in obtaining planning permission, details of any economic benefits and possible environmental conflicts ensuing from proposed new developments. Information for this section was obtained from county council minutes and reports, local media and articles reviewed in environmental publications.

d) Technical problems associated with wind energy in general and energy distribution and storage, the results of which have been reviewed in a number of text books named in the reference section and reports compiled in the bi-monthly NATTA Newsletter, details of which are also found in the references.

e) An examination of actual opinion polls concerned with attitudes towards alternative energy. An analysis of polls undertaken by energy companies seeking planning permission, including that produced for the Awel Aman Tawe community wind farm project.

It should be noted that, at the outset, the author has approached the subject with an open mind, having had little or no previous information with which to reach a definitive conclusion -- as have the majority of the general public. Any conclusion reached for or against should, therefore, be seen as being reached after careful consideration of all the information outlined above.

‘Places privileged by nature have been cursed by history’

Eduardo Galeano

Asmus. P (2001) ‘Reaping theWind’

SECTION 1
A STUDY OF LARGE SCALE WIND GENERATION SCHEMES--
OPPORTUNITIES AND CHALLENGES.

Foreword

The concentration of carbon dioxide in the atmosphere is already higher than for possibly 3 million years. This is having a discernible effect on the climate, resulting in global warming. (IPCC 2001) At the same time demand for energy in the UK is rising slowly. This increase is linked to the growing output of goods and services associated with economic growth, the rising number of households and the gradual increase in population.

Whilst the emphasis in manufacturing industry has largely moved away from an outdated heavy industry, with high energy demands, to one dominated by smaller, more energy efficient units, information technology and service industries, the overall energy consumption has risen. (DTI DUKES 2001) Coupled with this is an ever increasing demand for 'white' goods, televisions and central heating.

Since the start of the new millenium a growing number of reports and papers have all reinforced the idea that any increase in demand should be accompanied by a steady decline in carbon dioxide levels. In 2000 the Royal Commision on Environmental Pollution (RCEP 2000) estimated that in order to remain part of the worldwide effort to cut global warming, the UK must make 60 per cent savings in carbon dioxide emissions by the middle of this century.

Following on from this report, an energy review undertaken by the Cabinet Office's Performance and Innovation Unit concluded that '10 per cent of

Britain's future electricity needs should come from renewables by 2010, against less than 3 per cent being achieved today.'(PIU 2002) After further consultation with interested parties, including the energy industry, the aims and objectives set out in both reports culminated in a government white paper. (DTI 2003) Here the initial modest aim of 10% of electricity from renewables by 2010 was adopted. It was also hoped that further incremental targets of 15% by 2015 and 20% by 2020 could be achieved, given the right conditions. If these long term targets were reached then the prospects for reaching the even longer term target of a 60% reduction in carbon dioxide emissions by 2050 might be possible. However, it was also emphasised that for such a cut to be possible, 'large changes would be needed in both the energy system and in society.' It would also require government to give a much higher priority to energy efficiency and a change in public attitudes, with people linking their own day-to-day use of energy with fossil fuel consumption and the consequent threat of climate change. Such a change would only be accomplished by considerable encouragement and pressure from whichever government was in power.

The White Paper recognised that the use of some fossil fuels, especially natural gas, would continue for the foreseeable future. At the same time it was hoped that the development of Carbon, Capture and Storage (CCS) technology could overcome the obvious disadvantages of certain fossil fuels. The White Paper went on to outline other sources of energy which have emerged as potential alternatives to fossil fuels. Exploiting these will, in turn, give rise to a wide range of impacts on the environment. Such impacts need to be taken into account from the outset in deciding what role alternative

energy sources can play.

At the moment, nuclear power is the major source of carbon-free energy in the U.K. A number of nuclear power stations have, however, been decommissioned or are reaching the end of their useful life. Unless new plant is built therefore, nuclear power will have ceased by around 2036. The lead time for any new plant to come on stream will run into many years and the cost is likely to be excessive when compared with gas or clean coal plant. (PIU 2002) Any new nuclear power stations will also have to overcome the problem of managing nuclear waste, finding an effective long-term repository to accommodate such waste, plus waste that already exists.

Though it is intended that renewable energy sources such as wind, wave and solar power will provide up to 20% of electricity needs by 2020, the rest will have to come mainly from natural gas fuelled power stations. The introduction of any new renewable energy source will require an increase in the amount of finance available for both research and production. At the same time a major overhaul of the current planning procedures is needed in order to make it easier and quicker for new developments to come on line, whilst taking due account of any local or environmental problems which may arise.

The debate about any non-fossil energy plan for the UK revolves around two main sources, nuclear and wind. Biogas and hydro are the main renewable sources at the present time : much of the UK's current non-hydro renewable comes from biogas -- the product of sewage gas, landfill gas and animal waste. Some other sources of renewable electricity, including wave and biomass (i.e. 'energy crops') are still in their infancy or unproven. A tidal

barrage, based on the success of a French scheme on the Rance Estuary in Brittany, has long been considered for the Severn Estuary. Hydro energy, a major source of energy throughout the world and one which has proved successful for several decades in Wales and Scotland, was not seen as having a significant impact on any future energy plans, since it had been assumed that all major sites had been exploited and the environmental damage too high. Renewed interest in this form of energy has however, been shown in Scotland with the building of 150MW hydro power station at Glendoe. Solar thermal energy (heat) is already well established globally, whereas solar PV (electricity) is much less widespread, there being less than 6MW of PV in place in the UK up to 2004, and it would be considered too expensive to introduce widely into the UK at the present time, especially when compared with wind energy. In 2004, when considered in relation to energy based on fossil fuels and nuclear power, renewables (hydro, solar PV, wind, biomass, biogas and wave) only supplied 3.58% of UK electricity. (NATTA 2005)

If the argument for one or other of these sources is based purely on economic and technical facts alone-- and this is usually not the case-- then the result is far from clear. Windpower is certainly an endlessly renewable, clean resource with no problems of waste disposal, health or security risks. Because of its geographical position, the United Kingdom is the windiest country in Europe, and therefore eminently suitable for such an energy source. When capital costs, past subsidies and long term future liabilities are taken into consideration, windpower could become the cheapest form of generation technology in the next 20 years. Windpower may be the principal means by which the targets for renewable energy proposed in the energy

white paper could be reached.

It is the purpose of this thesis to outline the case for windpower and to examine the advantages and disadvantages of this form of energy and to outline a number of important hurdles which will have to be overcome if wind power is to play a significant part in future UK energy plans.

In recent years it has become *politically expedient* to press ahead with the building of ever larger wind farms in order to reach the prescribed targets for renewable energy, regardless of the pressure placed on the local environment and a lack of urgency in developing other forms of renewable energy and/or energy conservation. The case has often been made for wind power to be a major player in the overall picture of future energy supplies in the UK. (SDC 2005) However, progress so far has been slow due mainly to planning constraints, continued opposition to wind projects and increased costs.

An analogy can be made with the problem of how best to cope with the increasing number of vehicles on UK roads-- something which in itself represents a major source of atmospheric pollution and a subsequent increase in global warming. There is little priority or urgency given to reducing the number of cars on the road, research into new forms of motive power e.g. electric or hydrogen power, and the removal of heavy traffic from roads to the railways. Despite the government's proposal to set a target of 5% by 2010 for a renewable fuel transport obligation for biofuels (RFTO) and the introduction of toll roads, the main thrust of the government's answer to the problem at the moment is to announce a further massive investment in the building of new roads and the widening of existing motorways.

SECTION 2

THE LONG TERM FUTURE OF ENERGY SUPPLIES IN THE UNITED KINGDOM, AS OUTLINED IN GOVERNMENT POLICIES

The aim of this section is to examine two similar government white papers commissioned in 2003 by the UK government and the Welsh assembly, which together set out how best to fulfil future energy requirements. Consideration is given to outlining a number of important aspects of these papers, which will be developed in greater detail in later sections, especially where they relate to wind energy. These include planning, public perception and the effectiveness of wind energy.

i) Environmental challenges

Early in 2003 a major document setting out the strategy for long term energy policies in the United Kingdom, was presented to Parliament in the form of a White Paper. (DTI 2003) At the same time the Welsh Assembly, (in the form of its Economic Development Committee) published a Review of Energy Policy in Wales, with particular reference to Renewable Energy. (EDC 2003)

The 2003 White Paper built on a report by The Performance and Innovation Unit (PIU 2002) and on other reports and consultations which have looked at major areas of energy policy. The object of the consultation was for those organisations which have a particular expertise or interest in energy issues to review and comment on the government's proposals, as laid out in the PIU report. During the consultation period the views of primary energy producers, industries involved in the development of renewable energy systems, trades unions, those

environmental groups directly affected by the new proposals and scientific advisers and academics were sought.

Of the other reports that contributed to the final White Paper the report published by The Royal Commission on Environmental Pollution (RCEP 2000) also pointed out two major aspects of the energy debate which have often been overlooked or even sidelined in the drive for alternative energy, namely energy conservation and the relative role of the UK compared to other countries.

One of the main aims of the RCEP study was first to, 'identify the actions needed to reduce the UK's overall energy consumption without damaging its international competitiveness or causing hardship' and secondly to 'emphasise that the threat of major changes in climate is a task for the entire world community.' The future will see a situation arising where 'the developing world's consumption of fossil fuels is rising rapidly as it industrialises and living standards rise.' Under these conditions it is highly likely that its emissions will overtake the combined emissions of the developed countries.

The White Paper set out to address the three major challenges confronting energy policies over the next twenty years. The first was to address the threat of climate change and the rise in the levels of carbon dioxide in the atmosphere. At the same time, a reduction in the levels of indigenous oil, gas and coal production in and around the United Kingdom would make the country a net energy importer. Any move away from all or some of these energy sources would require a major restructuring of the energy infrastructures. Whilst the United Kingdom energy market is controlled

by a number of different energy producers and financed on the open market by private companies, it is still the 'Government's responsibility to set overall goals for UK energy policy and to ensure that our energy markets and other policies deliver those goals.' (White Paper 2003)

Having outlined the reasons for and effects of climate change, with the increase of carbon dioxide levels over the 20th century being the major contributory factor, the White Paper recommended that there should be a reduction in carbon dioxide emissions of 60% from current levels by about 2050. At the same time however, unless there was an introduction of some form of punitive restrictions or tax measures, the expected steady rise in the demand for primary energy by the public will continue unabated. The continued rise in the number of vehicles on UK roads and increased air traffic is also a major cause of pollution, making the task of setting specific targets for the reduction of carbon dioxide levels much more difficult.

Coupled with the need to reduce carbon dioxide emissions is the decline of the indigenous fossil fuel energy supplies. A shift from being a net energy exporter to once again being a net energy importer, may well leave the UK more vulnerable to price fluctuations and interruptions to supply.

ii) Energy diversity.

If, however, we are to maintain the energy supplies necessary for economic growth, then it is argued that this can only be achieved by energy diversity. 'We need many sources of energy, many suppliers and supply routes.' (White Paper 2003)

Whilst becoming increasingly reliant on imports the gas section of the energy industry is still expected to expand and the construction of gas fired power plants will continue into the foreseeable future. It is also possible that the few existing coal fired stations may be retained and/or new ones built, since it is now possible to store (sequester) carbon dioxide emissions from them in old undersea gas or oil wells. Despite these forecasts however, a much greater effort and the necessary finance will be required to limit carbon emissions and improve air quality if gas and coal are to play a major role in future energy diversity schemes.

In order to avoid over dependency on imports, a move towards developing renewable energy will be essential. Since research into many forms of renewable energy has been underfunded and slow to develop, the main burden of this shift in policy will fall on energy derived from wind power.

At this point however, it should be said that a number of countries do not intend to follow the route of 'electricity diversity', either because they have considerable natural resources e.g. gas or hydro or because they have reached a decision on one main source of energy, as is the case of France which is committed to nuclear energy, currently (2006) standing at 78% of its electricity needs.

With the move away from older, more traditional means of electricity generation towards that produced by renewables will come the third challenge- the need to update much of the UK's energy infrastructure. The onset of renewable energy will call for a major alteration to the infrastructure of energy distribution networks. Networks which were

‘designed for one-way transmission from large, centralised power stations to consumers-- will need to adapt to more renewables, often in peripheral parts of the country or offshore.’ (White Paper 2003) This applies in particular to the proposed large scale wind farms situated many miles offshore, with the high costs of bringing the energy generated to large onshore distribution centres.

In the same way that gas fired plants will continue, nuclear power may still have an important part to play as a source of carbon- free electricity. Whilst the decision to build new nuclear power stations is pending, there will still be a sizeable contribution from existing stations. The Magnox nuclear reactor closure programme is ongoing-- some are already closed. The AGR’s (Advanced Gas-cooled Reactors) will follow, one by one, leaving just the 1.3GW Sizewell PWR (Pressurized Water Reactor) power station which is expected to close by 2036. Although the Government may meet its target to obtain 10% of the country’s electricity supplies from renewable sources by 2010, renewables may not *at that time* (2036) be in a position to supply the major proportion of an expanding, energy dependent, economy. Any large increase on the 10% could mean a huge increase in the number of turbines, something which may well be vigorously opposed.

As previously mentioned, although much emphasis is placed on the future role played by a variety of renewable energy sources in reducing carbon emissions, paradoxically the government maintains that ‘coal fired generators will have an important part to play in widening the diversity of the energy mix.’(White Paper 2003) It is hoped that future research will

result in cleaner coal technology but again this will have to rely to a great extent on imported coal. The reluctance to phase out coal and gas fired power stations -- major sources of carbon dioxide emissions-- and the current ambivalent attitude towards nuclear power, indicates that total reliance on renewables (and in practice for the immediate future this mostly means wind energy) is not seen as viable. When *in use* wind turbines are very efficient-- they can theoretically convert up to 59% of energy in the wind to power, but more typically this figure is around 35 - 40%-- whereas conventional and nuclear plants only convert around 35% of energy in the fuel to electricity. The downside, however, is that they have a low annual capacity factor of around 30-35% compared to 70-80% for fossil /nuclear plants.

The eventual structure of the energy industry will depend in a large part on efforts to significantly reduce the amount of energy used in the home and in industry and to improve energy efficiency in buildings and tradeable goods. It is also acknowledged that it is essential to maintain the reliability of energy supplies. Gas and oil supplies need to be safeguarded, along with 'the assurances that the market will invest in the capacity we need to provide reliable energy supplies- in particular to meet peak demand in exceptionally cold weather.'(White Paper 2003) This latter goal was emphasised in the light of the collapse of the energy market in California in 2000 and the power blackout throughout a number of states in America and Canada in August 2003. A combination of rapid population and economic growth during the late 1990s lifted California's electricity demand by 20%. At the same time, the 'net addition of new

generating capacity, in what is perhaps the world's most NIMBY-conscious jurisdiction, averse to building any new generating plants, amounted to a mere 1.4% of the 1995 total.' (Smil 2003)

It is implicit, therefore, that the energy system in 2020 is likely to be much more diverse than today, with a greater mix of energy, especially electricity sources. It is envisaged that 'the backbone of any future electricity system will still be a market based grid, balancing the supply of large power stations. But some of those large power stations will be offshore marine plants, including wave, tidal and windfarms. Smaller onshore windfarms will also be generating.' (White Paper 2003) There will, however, be an ever-present need for a backup capacity to handle any intermittent generation, during periods when weather conditions reduce or cut off supplies from these major sources.

It is expected that backup capacity will be provided in the main by gas fired generators, with new 'clean' coal generators playing a smaller role, if this form of energy proves to be technically possible. These will be required because although nuclear power can provide 'base load' power, it can not be 'run up and down' quickly enough to act as a backup power for intermittent renewables. What was most obvious in the 2003 White Paper, was that the proposed energy system for 2020 only includes one nuclear power station (Sizewell B), despite the fact that nuclear currently (2004) provides 23% of UK electricity requirements. Since most of the existing nuclear power stations will have reached the end of their working lives by 2030, and since the lead time for the introduction of any new power plant will be lengthy, any decision about new plant will

have to be made in the next few years. What is fairly likely - and implicit in the 2003 White Paper- is that even with a greatly expanded programme of large offshore wind farms and despite the well documented shortcomings of nuclear energy, several new nuclear power stations may well be needed to fulfil all energy obligations.

In outlining the future energy requirements for the next two decades the 2003 Energy White Paper expressed goals only as aspirations, rather than commitments. The most striking example of this is the share of electricity to come from renewables. The 2010 target 10% is maintained, and there is a further aspiration to double the renewable electricity share by 2020, but this is 'not the same as setting a 20% target and pledging the policies -- and where necessary the funding -- to get us there, which was what Number 10's own Strategy Unit had recommended.' (East et al 2003)

There was no clear indication of how different technologies fit into the picture in the government's agenda. The £348 million figure given for government spending on renewables over the next five years included only £60 million in new money. It was, therefore, left to the energy market as to which technology they will invest in.

iii) The Development of an Energy Policy for Wales.

At the same time as the 2003 UK Government White Paper was being released the Economic Development Committee of the Welsh Assembly published its Review of Energy Policy in Wales with particular reference to Renewable Energy. (Jan. 2003) The Review was, in the main, a parallel document to the White Paper. It did, however, include a number of important recommendations specific to the development of renewable

energy in Wales. It was based on a consultation report prepared by the Economic Development Committee in April 2002, in which it set out a vision that renewable energy ‘emphasises safe, clean and secure energy supplies and contributes positively to reducing global warming.’ It goes on to propose that such a policy will provide ‘opportunities for industrial and rural development, long-term employment and increased prosperity.’ (EDC 2002) This emphasis on long-term employment was an important consideration in Wales, where unemployment was higher than the average in the rest of the UK and where there was a need to replace a declining iron and steel industry, and a downturn in the South Wales electronic industry. It was also at pains to stress that the Welsh Assembly should promote the vision by ‘*pursuing well thought out policies*’, an important point to remember in the light of some of the difficulties faced in the planning stages of several new onshore wind farms. In reaching a number of recommendations for the final report, several important general themes emerged, some of which did not run parallel to those reached in the UK White Paper.

One of the strongest themes to emerge was the view that Renewable Energy in any form should not be ‘*considered before, or separately from, the wider issue of reducing energy consumption overall -- including energy used by transport.*’

This view was not restricted to people opposed to the development of new forms of energy but was a common theme reflected by a large number of those involved in the consultation period. As a result, it was thought that priority should be given to the installation of solar panels

and higher levels of insulation in all buildings especially domestic properties.

Whilst it was generally agreed that it was necessary to increase the amount of electricity generated from renewable sources, it was the clearly expressed view that this *'needed to be done sensitively and so as not to prejudice tourism or areas of environmental significance.'* (Final Report Jan. 2003) Only in one or two cases did respondents to the initial consultation report prepared by the EDC indicate that the situation was so serious that there was no alternative but to act and that the cost of this would have to be faced up to.

iv) The development of wind energy

The widest range of views was on the subject of wind energy and the fact that, geographically, Wales was ideally suited to the development of wind energy.

At the same time, however, wind farms needed to be sited on, or close to, some of the most environmentally sensitive areas in Wales, something which has always given rise to the most heated debate ever since the establishment of the first major wind farm. Again, whilst the majority of respondents were in favour of wind energy, the important issues that the siting of wind turbines posed for tourism and the visual environment had to be carefully considered.

Others questioned the widely held view that there would be economic benefits with the introduction of wind energy, especially in the form of job creation. The development of wind energy, would seem, at first sight, to offer opportunities for highly skilled jobs, investment and for Wales to

establish itself in a key technological area. However, in reality ‘very few *permanent* jobs would be created by wind energy-- and given that other countries, particularly Denmark, were further advanced than the UK, any expansion in Wales would simply draw in surplus technology from elsewhere.’ (EDC 2003)

The Welsh report placed a much greater emphasis on the advantages and/or disadvantages of onshore wind farms than that outlined in the White Paper. This may have been because it was considered that Wales had considerably more experience over the last decade of the impact of onshore wind farms. Indeed it was even suggested that ‘many felt that their part of Wales had already contributed more than its share’, towards the overall strategy for renewable energy in the UK. There was also a ‘difference in perception about the level of jobs and the scale of the benefits available from renewable energy.’

v) Renewables targets for Wales

On the subject of future targets to be set for renewable energy, the Final Report (EDC 2003) was as vague or even as muddled as those set out in the White Paper. There were different views on the way that Wales should set a target for itself, but in a somewhat parochial fashion, the general view of respondents was that Welsh electricity consumption rather than Welsh production should be used as a basis for any target. While many respondents were in favour of setting a target, few addressed the target itself. It was even suggested that it was pointless to set targets without specifying how they would be achieved.

This basis for the setting of future targets for renewable energy, was set

out in a prior consultation report for the National Assembly (EDC Part 1 2002). Wales was expected to see its energy needs, how it meets them, and its contribution to reducing carbon emissions and global warming, in the context of developments elsewhere within the UK and the rest of the world.

What should be taken into account, however, is that Wales has a proportionally larger industrial base than the rest of the UK, including steel making, oil refining and electricity generation. The demand for heat in Wales is higher than the UK average due to this larger industrial base; for example 42% of gas supplied in Wales is to industry compared to 27% in the UK. An example of this type of energy demand can be seen at the ex NSW steel wire factory in Cardiff, recently taken over by Celsa-Barcelona, where a new electric arc furnace requires 40MW of electrical energy. Throughout the UK, however, heavy industry is declining and with it the demand for heat energy and there tends to be more scope for reducing heat demand than electricity demand through energy efficiency measures.

In the final analysis it was recommended that the Welsh Assembly should set a benchmark for the production of electricity from renewables sources of 4TWh per year. This figure for 2010, is based on existing plans and amounts to just over 10% of the total Welsh electricity production. The figure would be made up of roughly equal parts of electricity produced by onshore and offshore wind farms, and other renewable sources. It was assumed in the EDC report that 'other renewable sources' would include production from biomass, waste schemes and tidal flow none of which are

close to fruition.

The PIU Energy Review had recommended a renewables target up to 2020, in order to strengthen the case for commercial investment to 2010, as well as a continuing commitment beyond this date. If Wales were to adopt a similar approach, then a specific target of around twice the 2010 target would be required for 2020. This could well result in a major problem, wherein the initial renewable developments are likely to focus on the prime sites and when these are fully utilised the economic and planning cases will become harder to make. There is increasing evidence to suggest that this may be the case with regard to new onshore wind farm proposals. The development of new offshore wind farms will, it is hoped, help to mitigate these problems and make such a target possible.

vi) The possible adverse effects of planning processes for renewables, in particular wind energy.

The thorny and mostly inconclusive subject of whether there was any evidence that wind turbines could adversely affect tourism was debated. Whilst several organisations asserted that turbines sited on hills could adversely affect tourism, the Committee had found no evidence of this. At the same time it should be noted that very little conclusive research regarding the effect on tourism had been attempted anywhere in the UK. Any research into such a sensitive subject is not quite as straightforward as it may first seem, as is the case of 'public opinion' - see section 5.

The Committee did however concede that the 'fact that there is no evidence of an adverse effect, does not mean that no such evidence exists.' With this in mind the Welsh Assembly would continue to monitor

the information that is available from its own and other sources. This was an important concession in the light of future plans for larger onshore wind farms, consisting of many wind turbines well over 100 metres in height.

An equally important recommendation was that concerned with the means to 'clarify and streamline the planning process for renewable energy developments.' At the same time it was necessary to ensure that such developments would provide immediate and tangible benefits to the local communities in which they are located-- something which had so far been lacking. What was considered as important by all parties was that the planning process was efficient and made without undue delay, but that *'these decisions must be made democratically'* and that when decisions were required for wind farms in Wales that 'the Welsh Assembly should have the power to decide planning applications of all sizes.' (EDC 2003) A minority expressed the view that Wales could not, or indeed should not, consider its needs in isolation from the UK.

The final recommendation looked at the need to identify the energy sector as a sector with high growth potential in Wales, resulting in the creation of a significant number of jobs along with the parallel development of new skills. This has always been one of the strongest arguments for the increase in finance and support given towards the growth of the renewable energy industry in Wales. It was always hoped that this would go some way towards solving the problems of large job losses which occurred with the closure of a number of heavy industrial plants in South Wales.

Many respondents saw a parallel with the 1970s and 80s, when there was a rush to build new and extremely costly factories, mainly for the electronic industry. Thousands of skilled jobs were created, but with the downturn in several Far Eastern economies, including Japan and South Korea, these factories have either closed or are greatly reduced in size. Other false dawns included the opening of a number of new call centres, several of which have recently transferred to India, resulting in unemployment figures rising once again.

There were doubts as to 'whether there were significant jobs to be created in the sector and expressed the view that an expansion would lead to an increase in imported wind turbines.' The Committee recognised that a focus on this sector would not create large numbers of jobs overnight, but that Wales has the potential to become a strong player and from that, to export both expertise and technology to the world.

Since this report was put together in 2002, it can be clearly seen that the promise of high growth potential in this industry has not been fulfilled nor is likely to be in the near future. The large offshore wind farm constructed at North Hoyle, off the North Wales coast, should have given an indication of the potential for job creation in this area. It is true that when this particular wind farm began to generate electricity, around eight to ten full time skilled jobs were created to maintain the turbines and onshore installations. The turbines themselves were manufactured in a Scottish factory under licence from the Danish firm Vestas. At the same time, the towers had been constructed in a yard at the Mull of Kintyre, Scotland and shipped to Mostyn Docks ready for erection on site. Even the

specially designed ship used in the erection of the piles and towers was built in the Far East.

vii) Renewable Energy: 'Myths and Legends'

As an Annex to the Final Report, a number of important claims and common misconceptions were outlined and responded to. One of these was the idea that 'Developers of wind farms make profits from public subsidies', something which the authors of the report refute. They acknowledged that since 2001 suppliers of electricity have been obliged to buy a percentage of their supplies from renewable sources, or pay a surcharge equivalent to approximately 3p for each kWh of shortfall. This could be regarded as an 'indirect' subsidy paid for by consumers, but is deemed necessary in order to ensure the further development of renewable energy.

This 'indirect subsidy' was looked at in much closer detail by the Consultant to the Council for the Preservation of Rural Wales (CCPRW), Geoffrey Sinclair (*CymruWledig* Rural Wales Spring 2003). He calculated that for the Cefn Croes wind farm alone, this would amount to £12,636 a day or £4.6m in guaranteed sales during each of its projected 25 years (58.5MW capacity x 8760 hrs @ 30% capacity factor x £30/MWh), which would amount to a total of £150 million.

A small example of how the use of subsidies and financial inducements can be used to influence any further developments can be seen at the wind farm based at Moel Maelogen. This site was once hailed as the ideal small site, similar to those found in Denmark, and a winner of a top environmental award for sustainable energy. The group behind the

construction of the 3 original wind turbines on a farm close to Llanwrst, now want to build a further 11 turbines costing £2.5 million on the same site. The original 120 ft high turbines will be superseded by larger, more powerful turbines-- at 90m high amongst the tallest in Wales, which, it is hoped will supply power to nearly 9000 homes.

The new planning application being considered by Conwy County Borough Council, will it is said 'break a promise given with the original application to the local population that the group will stop at 3 turbines.' One of the three cooperative members denied that there ever was a pledge for only 3 turbines and that local people would be given the chance to invest in the new wind farm, with a possible 8% return on their money. It was expected that the project would result in around £60,000 a year in windfarm profits from Renewable Obligations subsidies, which in turn would be matched by the European Union -- a total of £120,000.

It is interesting to note that nearly all this type of application indicate the number of local homes that can be supplied with energy, whereas the electricity generated by the wind turbines always goes into the National Grid. This is so local people do not only benefit from reduced energy prices and any increase and/or decrease in national tariffs is felt throughout the country.

A further claim that the Economic Development Committee were at pains to dispel, was the argument that on days when there is little or no wind blowing, the required electricity has to be generated by non-wind power stations. Even when there are hundreds of wind turbines in existence, we will also need a number of the existing power stations, whether they be

gas or hydro electric. It was pointed out, however, that because wind generators will be spread out across the entire UK, the availability of electricity generated from such sources will be smoothed out. The Committee also pointed out that even though conventional power stations will continue to be used, there will be a reduction in the use of fossil fuel. This will bring about a reduction in the carbon dioxide levels which are held responsible for climate change-- the main aim of renewable energy.

viii) The long term effects of wind energy on tourism.

The third and possibly the most contentious claim, as far as Wales is concerned, is the one that ‘Wind turbines will destroy tourism in Wales.’ It has always been assumed in the past, that in order to reach the governments target for renewable energy, there would be a need for a very large number of turbines to be erected in Wales. Because of the nature of wind energy most, if not all of these turbines, would be visible in many of the favoured tourist areas and as a consequence this could well have a detrimental effect on the tourist industry. In its initial Review of Energy Policy the EDC estimated that renewable energy deployment in Wales would require about 200 onshore wind turbines. The new aspiration of 20% renewable energy by 2020 has already made this figure obsolete. Planning permission for several large wind farms has been granted and others are under consideration, all of which has increased hostility towards this form of alternative energy.

The completion of the large offshore wind farm at North Hoyle and the introduction of several other similar projects, may well counter the current ambivalent attitude towards onshore farms. (See Sect. 5 ‘Public perception of wind power’). The Final Report comments that at the time

of the initial investigation into renewable energy ‘there was no objective evidence as to whether wind turbines increase or decrease tourism in a particular area.’ Surveys in other areas, notably Scotland, reported that the majority of people are not influenced one way or another by the presence of wind farms.

In an examination of this survey, based on tourists visiting Argyll and Bute , the CPRW’s consultant (Rural Wales Spring 2003), was critical of the way the EDC had quoted from the press release without looking carefully at the details of the survey. During a public enquiry in November 2002 into a proposed wind farm at An Suidhe, Inveraray, the British Wind Energy Association and the Scottish Renewables Forum had claimed that 91% of visitors to the area said the presence of the three wind farms already in existence made no difference to whether they would return. As consultant for the local community council opposed to the new proposal, CPRW’s consultant claimed that in fact, of the total number of interviewees, only 20% had actually seen any of the turbines-- and these were examples of earlier, smaller turbines. Some 80% had not even seen the wind farms and this included over 20% who merely knew of their existence. Despite this apparent distortion of the facts, this particular MORI survey was widely used to claim that 90% of tourists are not affected by wind farms.

Whilst many of these surveys are generally in favour of wind farms almost all contain figures which suggest that there is an element of doubt within the general population and that they cannot always be taken at face value. This opposition to onshore wind farms on or near popular

sites is likely to continue to increase in relation to the ever increasing size and/or numbers of turbines.

We see, therefore, examples of claim and counterclaim regarding the perceived effects of large wind farms on tourism-- something which is of considerable importance to Wales. The British Wind Energy Association and the various energy companies involved in the construction of onshore wind farms will continue to maintain that, even with the advent of larger turbines, the effect will not be detrimental in any way. At the same time, a number of environmental groups and equally important local people will, no doubt, keep up the pressure to halt the proliferation of large onshore developments.

In the decade since the construction of the first small and unobtrusive wind farms, opposition groups have become more sophisticated and informed. Whereas at one time they were often dubbed as obstructionists and NIMBYS, they can now turn to a wealth of information, facts and figures with which to oppose energy groups applying for planning permission. It may well be a mistake for the National Government to bring forward legislation, which, it hopes, will limit the use of public enquiries and curtail the type of opposition to planning authorities usually associated with applications for large scale wind farms. (DTI 2006)

At the same time, it may well be a mistake for the Welsh Assembly to dismiss the legitimate fears and objections as ' Myths and Legends', when their own view of the economic benefits and the threat to the future of Welsh tourism may be based on false premises.

ix) Conclusions to be drawn from an examination of both the government's and assembly's energy policies.

a) The realisation that the UK would become a net importer of gas within three years and oil by 2010, or even earlier, which would leave the country vulnerable to both price and supply fluctuations. (White Paper 2003)

b) The Government's 2003 White Paper omitted to set firm targets for renewables, instead it was the declared '*ambition*' to work towards a situation where carbon emissions had been considerably reduced. There were, however, no firm policies or the necessary funding towards 'the commitment to double (20%) renewables share by 2020.' The lack of a formal target backed up by government legislation, sends out a negative message to both investors and interested companies. This will also have an effect on the determination and design of future technologies.

c) There were no new, definitive, policy initiatives within the White Paper towards the drive for energy efficiencies. Some minor new incentives were outlined, along with the proposed tightening up of building regulations to ensure higher standards of energy conservation in future housing and offices. The vast majority of older housing stock was, however, a major contributory factor towards the steady increase in energy requirements.

Little or no mention was made in the White Paper of the effects on greenhouse gas emissions made by the rapid growth in public transport and air travel throughout the world. Whilst some progress had been made towards mass producing 'cleaner' electric road vehicles, it would be many

years before the internal combustion engine would be phased out. A number of towns throughout the UK had introduced new electric transport systems and major rail routes were being electrified, but these would require large amounts of constant electrical energy.

d) Although it was recognised that nuclear energy might be needed in the foreseeable future to complement renewable energy, the decision to open new nuclear power stations was left in abeyance. Some nuclear power stations have been shut down or will be phased out and there would be no new projects without 'the fullest public consultation and the publication of a white paper setting out the Government's proposals.' (White Paper 2003) However, it did not rule out the possibility that at some point in the future, some new nuclear build might be necessary in order to meet proposed carbon targets.

In their own report, the Welsh Assembly echoed the UK Government's sentiment towards a 'zero carbon electricity system', but recommended a target of 4 TWh/year for the production of electricity from renewable sources. They considered this to be a realistic figure for the year 2010, on the basis of existing and future plans and this would amount to 10% of Welsh electricity. This target would be made up of roughly equal parts of onshore wind, offshore wind and *other renewable sources*; however, in the longer term it expects onshore wind to play a decreasingly smaller part in this. In order to reach these targets the Welsh Assembly recommended that all local authorities should consider how they would meet such targets within their areas.

It is important at this point to note how the Welsh Assembly saw the

future of the production of electricity from renewables, especially in the light of ongoing events within the industry. The increasing problems associated with the siting of onshore wind farms-- ever larger wind turbines and controversial sites within/ or close to environmentally sensitive areas-- will have been offset with the opening of the North Hoyle offshore wind farm. As the first major wind farm of its kind in the UK, it might be hoped that it would go some way to reducing any perceived public objections to this form of renewable energy. Recent events (2005) have shown, however, that this may not always be the case. A proposed new, 30 turbine, off shore wind farm situated off the South Wales coast at Scarweather has met with fierce local opposition and although the scheme may yet be given the go ahead, none of the major energy companies are willing to finance it and as a consequence it has been put back to 2008 and beyond. However, since the output of this site will be considerably more than 50MW, the eventual outcome will be decided by the Welsh Assembly, regardless of any local opposition-- yet another bone of contention.

x) Offshore wind farms-- the future for renewables?

The Department of Trade and Industry (DTI) has carried out many detailed assessments of the future potential for different renewable energy technologies. UK electricity demands in 2001 was 340TWh, of which only 1TWh was supplied by wind power. (DTI 2002) The UK government has set a target of 10% contribution from renewable energy sources by 2010. Since large scale hydro power is considered fully developed, the main burden would fall on wind power, which would be expected to

produce in the region of 34TWh. This amount would need to be somewhat higher, since overall energy demands would have increased nine years on.

As part of another assessment in 1998 the DTI produced estimates of renewable energy resources in the UK for the year 2025. At the time there was a tendency to overestimate the potential for wind energy in future programmes and a more realistic figure showed that, allowing for a number of constraints, *onshore* wind would only produce 8TWh per year, i.e. approximately 3% of the then total yearly output. (Boyle 2004)

At the same time the outlook for *offshore* wind energy was considered much more encouraging by the DTI, with a practical potential of 100TWh per yr. by 2025. This would suggest that until other forms of renewable energy e.g. wave, solar, are sufficiently developed to contribute to the overall energy requirements, then offshore energy would be the major source. However, since the 1998 assessment was published, the greatest emphasis has been placed on the development of numerous onshore wind farms with, until recent times, little regard being given to the greater potential inherent in offshore wind energy. As a consequence, the progress made towards fulfilling the targets outlined for wind energy in general have been slow, due mainly to the increasing number of limitations encountered with onshore developments. Limitations include 'the state of turbine technology at any given time and constraints concerning the accessibility, planning and institutional restrictions surrounding proposed wind farm sites.' (Boyle 2004)

As turbines have increased in size, output and efficiency, the onset of ever

larger wind farms has meant major obstacles in the form of public acceptability and environmental concerns which have become increasingly difficult to overcome. With the completion of the North Hoyle offshore wind farm it has been shown, however, that most, if not all of these limitations can be successfully overcome.

The future of offshore wind farms was highlighted with the announcement by the Crown Estate of 15 new sites around the UK coastline. (DTI Dec. 2003) This will be the second round of leasing for offshore developments, the first having been announced in December 2000. One such site will be a 200 turbine project situated about 10 miles from the Denbighshire and Conway shoreline. The new site would be twice as far out as the North Hoyle wind farm and is expected to produce enough electricity to power 600,000 homes.

The first wind farm constructed in Round 1, at North Hoyle between Prestatyn and Rhyl, opened in November 2003. Other windfarms are planned for the North Wales coast including one at Rhyl Flats, opposite Abergele, construction of which was expected to begin early in 2005, however the start has been delayed indefinitely. The mast erected to monitor wind speeds at the site has been operating for almost three years. It is expected, that together these turbines will generate about 160 MW of electricity, but in total Round 1 could result in more than 500 turbines, generating 1.5GW of electricity.

Total energy output from wind farms already approved, coupled with the proposals for new wind farms will 'not only put us firmly on the path of providing 10% of our total energy needs from renewable sources, but will

help us meet our aspiration of 20% by 2020.’ (DTI Dec. 2003)

Round 2 of the UK offshore wind development will cover an area of shallow sea in the North West extending from the N. Wales coast to the Solway Firth and out into the Irish Sea. Whereas finance for Round 1 was provided by the issue of Capital Bonds and Capital Grants from the DTI , it is not known if there will be any provision for Round 2. The future of renewables may rely on the future performance of offshore wind farms. The completion of the North Hoyle wind farm and the announcement of the 15 new sites was seen by the then Energy Minister Stephen Timms as a ‘huge opportunity to enhance our manufacturing capacity and provide new employment, particularly in the remoter areas.’ (Daily Post 2004) Whilst it is true that North Hoyle has helped to keep Mostyn Docks viable after the proposed withdrawal of ferry services to Ireland and provided much needed employment during the construction stage, the lead time required for each new wind farm development in North Wales, would mean that completion could be achieved without further increases in the present workforce. An estimated 8000 jobs, most of which are located in Scotland, already rely on renewable energy. It is, however, over optimistic to assume that ‘this number could rise to between 17,000 and 38,000 by the year 2020.’

It was always hoped, it seems erroneously, that the building of large onshore wind farms could be done without prejudicing tourism or areas of environmental importance. A recent report by the Welsh Tourist Board indicated that the tourist/ holiday industry in Wales outperformed that of the rest of the UK during the first seven months of 2003. From January

to July, 6.6 million visitors stayed in Wales, an increase of 2% on the same period last year. The tourism income of £969m for this period would indicate an annual income of close to £2 billion, something which it is hoped can be repeated in subsequent years. These figures indicate the significant contribution that tourism makes to Welsh finances. It would seem therefore, that siting major engineering developments in or around those areas frequented by tourists does not make a great deal of economic sense. With the introduction of more numerous and larger turbines, the initial idea that wind farms would be an interesting and novel attraction in themselves, has begun to wane. It is also possible that siting large wind farms near to areas such as Snowdonia or the Brecon Beacons may come at too high a cost. The opening of the North Hoyle off shore wind farm brings with it the realisation that these important tourist areas can be safeguarded while at the same time efforts to reduce carbon emissions can be reached. It is significant that, as far as the author is aware, there are no large scale wind farms on or about South Downs, the Chilterns or the Mendips, areas of natural beauty and importance to the tourist trade in the south of the UK.

Above all, the evidence concerning the problems encountered in reaching targets, overcoming planning difficulties and public opinion for renewable energy, especially wind energy, would tend to show that the future emphasis should be on offshore wind farms rather than obtaining much of the energy from onshore wind farms as currently envisaged by the Welsh Assembly. However, as will be shown in a later section, even this concept is not without its problems.

In the next section, the author will review some of the particular issues facing the development of wind farms Wales. These include :-

- a) The obvious fact that some of the best and windiest sites in Wales coincide with areas which overlap three National Parks and a number of Areas of Outstanding Natural Beauty (AONB).
- b) The possible effect of physical and visual impacts on such sites.
- c) The economic benefits which may result from wind energy schemes set against a possible loss of revenue from tourism.
- d) Attitudes towards local planning applications.
- e) Where should the final decision on any individual wind farm be made, Cardiff or London.

SECTION 3

A REVIEW OF THE PROBLEMS ENCOUNTERED IN OBTAINING PLANNING PERMISSION FOR WIND FARMS IN NORTH WALES.

This section looks at some of the problems faced by government agencies, wind farm developers and local authorities. It uses extracts from letters and planning material submitted by a power company for an individual wind farm, Welsh assembly technical advice notes, local authority letters, county council minutes and letters submitted by national and local groups opposed to particular wind farm proposals.

In the late 1980s when the first wind farms were opened, wind power was seen as the epitome of all that was clean and green, a way of generating energy without producing carbon dioxide, sulphur dioxide or radioactive waste. Early studies by Chris Blandford for Dyfed County Council concluded, however, that “long lines of turbines should be avoided because they dominate the landscape, while clusters of between 10 and 30 turbines are less conspicuous.” (Blandford 1994)

At the same time the siting of these clusters has to be applied with care, “We’ve got to watch out that we don’t change from wind farms in the landscape to a landscape of wind farms,” says Blandford.

The main objection to early wind farms concerned the amount of noise generated by turbines. It was initially thought that this would not be a problem and restrictions on noise were not written into the conditions of planning permission. Indeed, there was, at the time, no standard method for predicting noise levels or for measuring actual levels once the turbines were erected.

Many of these early problems have been overcome, as part of a

continuous drive to further improve the performance and cost-effectiveness of wind turbines. These improvements include variable speeds, permanent magnet generators, and towers made with new materials and self-adjusting resonant frequencies.

At the same time, however, turbines have substantially increased in size, which has resulted in a move towards visual impact and environmental damage as the most significant problem encountered by proposed new wind farm sites. A review of the planning application for the site at Pentrefoelas, a site close to the Snowdonia National Park, highlights the difficulties that any proposal for a wind farm in North Wales, especially one of the magnitude outlined below, is faced with. On the one hand, there is a hardening of opinion as to the long term impact on the countryside of major schemes using some of the largest turbines seen in Europe, whilst on the other, some local community councils, farmers and industry see the same schemes bringing major benefits and investment to the local economy. An examination of correspondence between the Snowdonia National Park Authority and National Wind Power is very revealing as to the attitude taken by the opposing sides.

In attempting to answer some of the “incorrect or misleading information given to the members of the Authority” Peter Hinson, the Development Manager for NWP, highlights the strength of both sides, each attempting to press forward their own case. (NW P 1998)

i) The possible effects of physical and/ or visual impacts.

The National Park’s officer is concerned that the turbines will be 92m to the tip of the blades, “almost twice the height of the highest supergrid pylon”. In reply, Mr Hinson points out that the “highest pylons can be

70m or more”, ignoring the fact that there would be 28 such ‘pylons’ grouped together, each of them with blades which turn continuously, whilst emitting a continuous low level noise.

Mr Hinson goes on to assert that their (National Park) summary of the visual impact from within the park boundary is a “heavily subjective assessment which seems inappropriate for a Committee briefing.” He continues with the contentious remark that “the suggestion of negative impacts on visitors goes against all public opinion surveys to date, which show that a substantial majority of people like and support wind farms.”

He supported this argument with the results of 12 independent public opinion surveys canvassed over a number of years since 1990, which showed that ‘a substantial majority of residents who live in an area which contains a wind farm are in favour of wind power’ (Elliott 2001). The most telling statistic, obtained from a study in Scotland in 2000, suggested that, prior to construction, 40% of 430 respondents thought that there would be problems, whereas in reality only 9% actually reported any problems.

However, a survey of public opinion taken during the course of the enquiry into the Pentrefoelas site, suggests that this kind of result is not always universal and the introduction of ever larger wind farms, coupled with a major increase in the size of turbines, has resulted in a hardening of attitudes towards the proliferation of new onshore sites. (The results of public opinion surveys will be examined in greater depth in a later section)

Any discussion concerning the visual impact of a wind farm of this size, located on a site 3km from the Snowdonia National Park and within a Site

of Special Scientific Interest, is bound to be 'subjective'. Some of the very reasons why the Snowdonia National Park was first set up, the beauty, remoteness and the sense of solitude found there can only be quantified in a 'subjective' manner. This is an area where several million pounds were raised in order to buy a small parcel of land within the National Park from a private landlord, in order to protect it from development.

An review of the Environmental Statement (ES) produced by National Wind Power for the Pentrefoelas wind farm site, was carried out by the Institute of Environmental Assessment. (IEA 1998) The review was described as a qualitative assessment of the ES, *which in itself, did not involve a site visit*, but which sought to ensure that all relevant information was made available to decision makers. In its review of the ES, the IEA criticises both the conclusion to the landscape and visual section and the significance of noise impact section. The ES maintains "that no significant adverse or unacceptable changes would occur to the landscape and visual baseline conditions." The IEA show however, that even based on the criteria outlined in the ES, " all of the visual impacts would be considered significant" (Review 2.2 Prediction of impact magnitude Para 3). In coming to these conclusions the ES makes considerable use of photomontage, something which G. Sinclair of Environment Information Services, when writing on behalf of the Council for the Protection of Rural Wales, describes as " the flawed depiction of landscape and of visual impact" (CPRW 1998.) He maintained that " the photographs compress the vertical dimension relative to the horizontal, in many, if not all of the viewpoint photographs." He goes on to say it

“flattens the views, produces too much foreground in relation to the distant subject of the view and does not reflect what the combination of eye and brain would see.” This is especially so, given the characteristic of turbines to “draw the eye” from their landscape context.

Since the mandatory Environmental Statement produced for any planning application plays a major part in the assessment and final analysis by members of the planning authority and equally importantly, that section of the general public present at a public enquiry or exhibition, it follows that such a statement must be accurate and not contain any misleading depictions of visual and other physical impacts.

As part of the public consultation programme for the proposed development of the Rhyl Flats Offshore Wind Farm, a series of exhibitions were held during April 2002 by Celtic Offshore Wind Ltd. (COWL).

Each exhibition featured 3-D computer-simulated animation and extensive display material, including a four volume Environmental Statement which contained computer generated images (a photomontage) showing predicted views from a number of local viewpoints. (e.g. Great Orme) It was stated that at a distance of 8km. from the Abergele coastline, this wind farm consisting of 30 turbines, each on 60 metre towers, with 35-40 metre long blades, will “not be audible from the shoreline and will only be visible in clear weather, appearing as a feature on the horizon”. (COWL 2002.)

COWL have erected a 50m tall wind monitoring mast in the area where the Rhyl Flats Wind Farm will be sited. Whilst this is a slim tower, half the size of the proposed wind turbines, it is none the less clearly visible from

the nearest coastline in good weather. One can deduce from this that 30 of the largest turbines ever built in this country will have a greater impact than has been outlined in the Environmental Statement. However, since this is an offshore wind farm 8km out to sea, it will not have the same effect on public opinion as a similar sized wind farm erected close by a National Park.

Whilst it is envisaged that ever larger wind farms will need to be built in order to meet the renewable energy requirements by 2010, the effect of any perceived *visual impact* will continue to be one of the major barriers to a successful planning outcome. New technology may go a long way to eliminating many of the problems of noise pollution, but 100m wind turbines can not be ‘camouflaged’ to blend into the surrounding countryside.

If photomontage is to continue to be used as a major component of an Environmental Statement, then considerable care will be needed as to how the final pictures are interpreted, since any false impression may lead to an unsatisfactory outcome to any inquiry or planning application.

At this stage it is useful to examine two different studies into the impact of wind farms on the landscape:-

a) In an earlier work on the use of public land for renewable energy schemes, by Walker (1995), it was thought that “ most studies of the opinion of the general public living near to actual or potential sites have concluded that overall the majority of the local public are positive about wind energy.” However, although there was high proportion of positive views in favour and that wind power developments had little impact, there was a greater support for smaller developments with one or two

turbines, than for larger windfarms. It was also obvious that where turbines are close to homes and within a regular line of sight there was a degree of dissatisfaction. This could be seen as a small example of NIMBYism, where there appears to be a degree of general satisfaction provided that it does not intrude into ones own locality.

The negative feature of wind turbines of most concern to people was, as is often the case, the visual impact. Importance was given to how turbines are perceived, including both the nature of the location and the characteristics of the turbines themselves.

Walker (1995) found however, that the rapid appearance of windfarms in Devon, Cornwall, Wales and the Pennines had generated a considerable amount of opposition from some members of the public, despite the apparent support for wind energy in general. The basis and origins of this opposition were at the time (1995) not clearly understood but a number of contributory factors were suggested. (All of which have more recently been studied.)

These included :-

- i) Sites have been selected for windfarm development which are of high landscape value, directly precipitating conflict between energy and landscape conservation interests. (Something which still exists today in 2006)
 - ii) Windfarms have been developed too rapidly, with inadequate local consultation and involvement.
 - iii) Local conflicts have been exacerbated by the lack of a coordinated national planning policy for alternative energy and windfarms in general.
- There was therefore, a difficulty in how to respond to the statistical

minority. Whereas it may be tempting to brush aside the views of those objecting to a development as not reflecting the majority of community opinion, it is important to realise that the minority of local people opposing a development may be those most directly affected.

If in an age where “professional lobbying and the use of the media ensure that the most loudly heard voices achieve political responses, but which in turn results in the concerns of those objecting to renewable energy projects being brushed aside, then there is therefore the danger that the opposition of interest groups is intensified.” (Walker 1995)

b) In examining the effect of wind energy developments on landscape in America, Pasqualetti (2000) considered that it is “the immobility and very visibility of wind power that makes its presence unavoidable. The more we wish to tap the power of the wind, the less we will be able to avoid the responsibilities that our demand for energy brings.” He goes on to say “that if wind energy is to expand, so too will wind-energy landscapes and the attention paid to them by the public”. However, developers should promote the benefits of wind power, but not at the risk of intruding on favoured (or even conspicuous) landscapes, regardless of the technical temptations these spots may offer.

He goes on to offer several solutions to this problem, including:-

- i) The wind power industry must incorporate all reasonable technical improvements to mitigate impacts and assuage public unrest. To accelerate the use of more efficient, more powerful and quieter turbines, whilst generating an equal amount of electricity.
- ii) Care to be taken to intelligently and carefully integrate turbines within

individual landscapes. Steps to be taken include attention to scale, symmetry of design and layout of the turbines in a less cluttered array. Such care can yield positive results, as the Danes have demonstrated.

He concludes that “ no matter how much we do to reduce the impact of wind turbines on landscapes, nothing can render them invisible.” We should be prepared to embrace wind’s visibility not as a problem but as an asset. If, therefore, the number and size of projects in Wales is kept within the bounds of what can readily be accepted by the general population, then whilst there will always be those opposed to wind farms in general, the actual percentage of objectors may remain the same.

ii) A view of the economic benefits from renewable energy schemes.

The concluding paragraphs of the NPA document and the subsequent NWP reply, reveals the fundamental differences which exist in an increasingly bitter battle to develop an alternative energy strategy.

The Snowdonia National Park Authority outlined its support for renewable energy schemes as “one where installations are of a scale compatible with the landscape of the National Park, so that the development can take place without detriment to the natural beauty of the park or its enjoyment by the public.” (SNPA 1998)

They (SNPA) see “developments of such (small) scale as bringing economic benefit to the local area, especially if they are able to be financed, at least in part, locally.” In contrast to this policy, they foresee the size of future wind farms getting larger, funded solely by the largest of companies which ensures that long term economic benefits from these schemes are not felt in the local area. Whereas a number of landowners and farmers will receive appreciable rents per acre or per turbine, people

living in local communities will not benefit from lower electricity charges, since the power generated is routed directly into the national grid.

In reply National Wind Power maintained that 'they know of no evidence to support this view of renewable energy economics' (National Wind Power 4th August 1998) and they go on to say that their (NPA) view of the economics of this scheme is 'incorrect and grossly misleading'. It clearly stated in the Environmental Statement for this application, that such projects generally lead to around 25%- 30% of the total project cost (app. £8mill.) being spent through local contractors. Cambrian Engineering, Bangor, would have supplied the steel towers for this contract and 3-4 local long term jobs for maintenance requirements would also be generated. There is, however, evidence to support the view that 'smaller can mean better'. Initially, opposition to wind farms was far less apparent in Denmark and Germany, where the majority of wind projects are owned by local people. 'In Denmark for example around 70% of the 3000 or so wind projects are owned by local wind co-ops--the Wind Guilds.' (Elliott 2001) With the original Danish co-ops using only the smaller machines available at the time, a large number of small unobtrusive wind farms were developed, which were seen as suitable for the flat landscape in much of the country.

With the advent of larger, more economical turbines (3-4MW), most of the earlier machines have been replaced. Whilst such replacements can easily be achieved without much opposition and the need for further planning permission, proposals for new onshore wind farms using ever larger machines can-- even in Denmark-- meet with increasing opposition. Hence the move towards offshore wind farms.

Several UK energy companies have looked at a number of small existing onshore wind farm sites in Wales (e.g. Llyn Alaw, Anglesey) with a view to see if they can expand them with larger machines.

Further evidence of the policy pursued by the National Park Authority, can be seen in the support given to the Conwy County Council's decision in 1999, to grant permission for a small wind farm of three turbines, situated in the hills above Llanrwst and clearly visible from within the park boundaries. Work began at the site, in the middle of 2002 after four years of preparation and the Moel Maelogen Wind Cluster is now fully operational.

Two 1.3 MW Bonus turbines are owned and operated by a Welsh consortium and the third is the responsibility of EnergieKontor, a German wind development company approached to help offset costs. The power generated is distributed to homes and businesses in and around Llanrwst. The towers were manufactured by Cambrian Engineering in Bangor and equally important 'the group is the first private company in North Wales to secure Objective One funding through the European Regional Development fund with the help of Conwy Council's economic development and regeneration partnership.' (NWWN 2002). The funding will pay 15% of the total cost of the turbines.

iii) Renewable energy or improved energy conservation and efficiency ?

The final part of the letter from National Wind Power, replying to the report prepared by the Snowdonia National Park Authority, is perhaps the most revealing. It indicates the depth of polarisation between the two parties in this instance and an example of the difficulties which planning applications for future large scale wind farms will have to surmount.

The SNPA (SNPA 1998) comment that it has always been the policy of the Authority and indeed the practice to support renewable energy installations which do not conflict with National Park purposes. However, the introduction of the Non-Fossil Fuel Obligation funding mechanism had encouraged developers to seek the windiest and most profitable sites in order to win contracts. (The NFFO has since been replaced by Renewable Obligations)

It is said that where energy is used with a lack of efficiency some form of new energy production capacity will be needed. Wind farms can, therefore, be justified in this context and any adverse effects such as the visual impact on the national park are at least temporary and can be rectified without long term damage. This does not, however, apply to nuclear and fossil fuel electricity production where the effects of these will be felt for generations.

If and when a 'better approach to energy conservation and efficiency, promoted and enforced by government, does not meet the required energy demands, then and only then should areas of such landscape quality as National Parks be threatened by the construction of large wind farms.'(SNPA1998) They said that present policies, encourage the growth of large scale wind farm construction. It can be seen as an easy, short term option, whilst at the same time, doing nothing to solve the larger problem of ever increasing energy demands.

National Wind Power dismiss the whole of this argument and suggest that council members have been misinformed and any comments are irrelevant to planning policy and are misleading. They insist that government policies on energy efficiency and on renewable energy

development are two distinct and separate matters. Government Policy is clear when it states that “ it is necessary to stimulate the exploitation and development of renewable energy sources *wherever* they have prospects of being economically viable and environmentally acceptable”.(White Paper 2003)

Even more illuminating is their belief that this “policy refers to such development even *within* designated areas, including National Parks, where a *balance* needs to be made between this policy and the basis of the designation.” (NWP 1998.) This attitude has recently been reinforced by a new proposal (not yet law) for all major planning decisions to be made at UK government level, thus by-passing local and county planning authorities. This measure was originally intended to expedite planning for a new runway and terminal at Heathrow, a number of large motorway projects and the use of greenbelt land for major housing developments in the the SE of England. However, it could equally apply to large onshore and offshore wind farms and any future estuary barrages.

In a corollary to this exchange of letters it should be noted that many of the original concerns expressed by the National Park Authority in 1998 have been realised with the announcement by Conwy County Council (Nov 2004), that the windfarm at Llanrwst can expand from 3 to 12 turbines. This decision was taken despite considerable opposition from locals and the two nearest local councils.

This decision also reinforces the attitude gaining ground throughout Wales that small local windfarms will be used, at some stage, as the ‘thin end of the wedge’ to bring about major multi-turbine developments throughout the principality. This situation is reviewed in a later section

iv) Who should have the final decision on any new wind farms, Cardiff or London ?

A recent example of the government's determination to push through proposals which reinforce their long term aim to produce 10% of UK electricity by 2010 was the decision to give the go-ahead for the Cefn Croes wind farm, which would have 39x1.5 MW turbines each measuring 100 metres to the blade tip. Whilst the Cefn Croes wind farm application was provisionally refused planning permission by the local Ceredigion Council, the final decision was made by the then Energy Minister, Brian Wilson in London, without holding a public enquiry and more importantly without recourse to the Welsh Assembly.

Whilst the views of a number of Welsh conservation groups who were in total opposition to the proposals were to be expected, the strength of feeling in the Welsh Assembly against the decision was of far greater importance. Elin Jones, Plaid Cymru AM for Ceredigion, said " Decisions on wind farms in Wales should be decided by the National Assembly, not a Westminster minister. I have been pushing the Government in the Assembly to secure the transfer of powers for all wind farms to Wales. Let's hope that Cefn Croes will be the last Welsh wind farm approved by a London minister." (Daily Post 2002). Simon Thomas, MP for Ceredigion, argued that it was " anti-democratic" to take the decision on the development outside Wales. The approval for Cefn Croes and the plan for a further 165 wind turbines in an area between Strata Florida and Llyn Brianne in the Cambrian Mountains, may well have an effect on the political viability of the Welsh Assembly.

The Assembly was formed as part of the present government's long term aim to introduce devolved government for the whole of the United

Kingdom- including the NW and NE areas of England. It was expected that with the exception of the general finance budget, taxes and defence, all other departments- education, health, transport, social services etc, would be controlled by each of the devolved areas. Removing decision making for major wind farm developments in Wales from the Welsh Assembly to London, on the pretext that this is in the national interest, will add to the already strong suspicion that the government only pays lip service to devolved assemblies.

Whilst it is recognised that because of its geographical situation, Wales has a significant part to play in the drive for alternative energy supplies, the Welsh assembly, in partnership with the relevant conservation groups, believe it should be allowed to make the final decision on any major new wind farm development. Failure to do so would result in a subsequent hardening of attitudes towards any future large scale developments in Wales, especially if as expected, targets for renewable energy may well be raised in the future.

v) Conclusions to be drawn from examining the Pentrefoelas application in the light of previous planning applications .

When National Wind Power first submitted their application for 28 wind turbines at the Pentrefoelas site on the Denbigh Moors, it could be assumed that their planning office had taken into consideration the history of any previous application for a site first identified in 1991.

An initial proposal by MANWEB Generation Holdings for 150 turbines, on what was seen as potentially one of the best sites in North Wales from the point of view of long term annual wind speeds, ignored the fact that it would be located on an extremely sensitive site. The importance and

sensitivity of landscape, ecological and recreational factors of a site 2.5 km from the Snowdonia National Park and well within the Mynydd Hiraethog SSSI, in itself a site on a list of nationally important areas for nature conservation in the United Kingdom, could be expected to engender fierce opposition from the Countryside Council for Wales-- the governments' own statutory advisor on landscape and nature -- and many other powerful organisations.

However, when the rights to the site were first acquired by NWP in 1995, it was wrongly assumed that the climate of opinion towards alternative energy needs had changed sufficiently, such that a revised application for only 28 wind turbines would be looked on in a much more favourable light. The authors of this application, submitted in May 1998, failed to appreciate however, that the proposed wind farm was still in the same basic location and that the details of the application, including the environmental statement, were not sufficiently well researched to convince the council of the viability of such an application. With this in mind it should not therefore, have come as a surprise that in June 1999 Conwy County Council decided to refuse planning permission for the new application.

By the time National Wind Power submitted their revised application for 26 turbines of a slightly smaller size, in a final attempt to overcome the reason for refusal, the council had moved on. They had begun an Environmental Strategy and Action Plan for the whole of the Hiraethog area, which included the proposed wind farm site, thus it was hardly surprising that this application was also refused in July 2000.

In replying to a letter received from the National Park Office (July 1998),

NWP appear to make the same mistake that many others working in the alternative energy industry have made--- that those who do not comply with this new revolution are branded as preservationists, Nimby or just plain reactionaries who do not understand and can be ignored.

NWP's planning officer writes "about his concern over some of the information given to members in your (National Park) Officer's Report to the Committee, which is incorrect and/or misleading and may have unduly influenced the members. Clearly it is the duty of the Authority to brief the Committee with all relevant information so that they, as elected members, can make a balanced judgement *based primarily on National and local planning policy.*" (NWP 1998).

He is either unaware or chooses to ignore the fact that this information was obtained from organisations with almost 10 years experience of analysing previous wind farm applications. In this time a considerable wealth of technical, economic and political expertise had been built up with which to oppose any *large scale* developments.

vi) What is required to produce a convincing Environmental Statement as part of a successful Planning Application ?

The primary objection to the Pentrefoelas site was always going to be its close proximity (2.5kms.) to the Snowdonia National Park. As such it was going to have "a significant adverse impact upon and diminish views both into and from this nationally important landscape." (CCW 1998)

The CCW refer to the Environment Act 1995, the background of which was set out in the Report of the National Parks Committee (England and Wales) 1947 in which it states that, 'The boundary of a National park should not, however, be regarded as a sharp barrier between amenity and

recreational values within, and the disregard of such values outside.'

They go on to suggest that in the event of this application being approved, the development of further wind turbines within and without the site would bring about an unacceptable cumulative impact upon the local countryside. Once a locality has been downgraded by the initial proposals, it would be impossible to resist successive proposals.

Alternative sites within this immediate area of N. Wales may have been considered by developers, but there was no information on the reasons for the rejection of these sites. This may also indicate that the Pentrefoelas site provided NWP with the greatest opportunity for financial reward, without due regard to the environmental considerations.

Important advice can be found in Planning Guidance (Wales) Technical Advice Note 8 (1996), concerning the development of renewable energy sources. This indicates that 'A completely objective assessment of the landscape qualities of an area and of the impact of development on the landscape is not possible. Nonetheless, methods of objective assessment can define both absolutes and questions of scale. Special considerations apply to applications in National Parks and AONB's in view of the very high quality of the landscape in those areas that warranted their designation.' (Welsh Office 1996)

In the light of the successful application and construction of 3 turbines at Moel Maelogen, Llanrwst, the same Planning Guidance suggests that 'siting criteria may be more flexible in the case of single turbines or groups of turbines supplying primarily the turbine owners themselves.'

All of the main objectors criticise the contents and methodology of National Wind Power's Environmental Statement (ES) for the

Pentrefoelas Wind Farm, especially the misleading depiction of visual and other impacts on the immediate landscape. Since the Environmental Statement is a major part of any wind farm application and something which is intended to inform both members of the planning authority and the general public, it is vital that any such statement is based on an appropriate and accurate use of all the relevant technical advice.

As previously mentioned, one of the major criticisms was the inadequacy of the 20km radius allowed for in the Zone of Visual Influence diagram. Since the ZVI concept lies at the heart of visual impact analysis, it sets out a rationale for selecting viewpoints and photographic depiction, and for the general description and analysis of the significance of visual impact.

The Campaign for the Protection of Rural Wales maintained “that the 20km radius of depiction of the ZVIs was inadequate in relation to the height of the proposed turbines (hub 60m and blade tip 95m).” A 15km radius was needed for the early turbines of half this height so it was safe to assume that the radius for these new turbines should be closer to 30km. (CPRW 1998) The correspondent, a consultant in this field, is critical of all the Viewpoint sites and photographs included in the Environmental Statement produced by NWP. For this reason he concludes that many of the people who were meant to benefit from reading this document, were at best, inadequately informed, or possibly even misled as to the full environmental impact of this proposal.

In defence of National Wind Power, the Institute of Environmental Assessment’s own review of the Environmental Statement indicates that the statement provided a thorough description of all components of the

proposal and the associated developments. The location was clearly described and shown on appropriate maps as was clear information on the likely impact of this proposal, resulting in a balanced document which was the result of extensive consultation. There was, however, no indication as to with whom and when these consultations took place, and it is significant that the resulting document conflicts with the arguments put forward by many of the organisations objecting to the application.

The statement was well presented in 4 volumes, complete with maps photomontages, pictorial representations of the proposed wind turbines, and a breakdown of every aspect of the application. This included possible visual impacts, noise pollution and adverse and unacceptable ecological and environmental changes. Despite having been put together in order to show the application in the best possible light and at considerable expense to the NWP (app. £400 per set), the principal objection, that of visual impact still remained unresolved. However, in spite of the concerns shown by the general public towards the impact this proposal would have on the environment, the statement was generally accepted at face value. Equally as important, those county officials who would determine the final outcome of the application and who in turn were advised by their own technical officers and consultants, supported the application.

A major problem with the review carried out by the IES , however, was that it was only a qualitative assessment of the NWP's Environmental Statement. It only sought to establish if the report *used best practice standards* and was well presented in a logical manner as laid down by the Institute. It did not take into account additional meetings or information supplied to the authority, pollution control and monitoring and/or the

conflicting views of other interested parties or organisations. It acknowledges that the authors of the Statement had provided a non technical summary as a separate document for use by a wider readership. The summary was in general a good reflection of the main document, but even this used a number of technical terms which could have been avoided or explained within the text.

It must be said, however, that by presenting the Environmental Statement in a favourable light, the IES had given support to what was perhaps the most important part of the whole application. *All this without actually visiting the site, something which was essential to understanding the particular problems associated with building a wind farm on an extremely sensitive site.*

vii) Do the possible economic benefits outweigh the objections ?

Where members of the public were concerned, there were still many who objected to wind farms per se, whilst others supported renewable energy, but felt that much more consideration should have been given to the location of individual sites, especially where a large number of turbines were involved.

Supporters felt that the wind farm would be of benefit to the locality, with some wishing to proceed in order to protect employment in the immediate locality, whilst others thought it would help future job prospects in the turbine manufacturing industry. Some also saw it as a means of possible diversification away from an already ailing agricultural industry. *It is unlikely, however, that many regarded wind power in a truly altruistic manner --- that it was a source of renewable energy used in order to reduce the reliance on fossil fuels.*

As an appendix to the final application for 26 turbines, a list of 542 names and addresses was produced. Many of the submissions were written on a pro forma letter and whilst the majority were from people living in Anglesey, Gwynedd, Conway and Denbighshire, there were two other interesting groups of respondents.

There were sixteen objections from the area around Asham-in- Furness, Ireleth and Cartmel in Cumbria and a further eighteen from Welney and Wisbech in Cambridgeshire. Both these groups have had considerable experience of living with wind turbines, within, or close by their communities. The experience of one resident in Asham was highlighted in a television broadcast, which showed a large turbine in close proximity to a row of houses. The biggest complaint in Asham was the lack of understanding, prior to the successful application, as to what effect the turbines would have on people's daily lives-- bearing in mind that these were erected some years ago and somewhat smaller than those expected on the Pentrefoelas site.

These objections tend to contradict a view supported by several opinion surveys, that people living in communities sited close to wind farms are generally supportive of this form of renewable energy. When put forward as an alternative to nuclear energy, (especially in areas close to the Wylfa and Trawsfynydd power stations) it is not difficult to see why many applications for wind farms have initially received favourable support from the general public.

The long term experience of people living close by wind turbines has resulted in a wide variety of results. In many cases the reality that turbines are not as noisy or as unsightly as first thought has overcome

initial apprehension. However, in those situations where clusters of turbines are sited relatively close to houses, in villages or suburbs, then many of the problems outlined by opponents of wind energy i.e. noise, visual impairment and possible reduction in property values are exaggerated. Despite the positive outcome suggested by numerous authorities, it may well be the case that in the drive for increased targets for alternative energy, which in itself would result in many hundreds of turbines being built on less suitable sites, then opposition will continue to rise.

A block of almost 50 respondents supported the application. They were the managing director and 47 employees of Cambrian Engineering (Cymru) Ltd, Bangor, the local firm responsible for the manufacture of turbine towers. The inclusion of this group of workers, most of whom live on Anglesey, or the surrounding districts of Bangor, highlights the often quoted advantage of the development of alternative energy in Wales— that of the economic benefits from inward investment and local job creation.

Much is made of this advantage but closer inspection suggests that the benefits are not widespread, or long term. When Pentrefoelas was called in and eventually rejected, Cambrian Engineering laid off 18 workers. Whilst a valuable short term contract, work on steel turbine towers was always going to be transient and subject to intense competition from firms outside Wales, and not the basis for long term employment prospects. Much of the work on the more lucrative turbine contracts is done by foreign firms-- for example the Danish wind company Vestas-- who do not have a manufacturing base in Wales.

Much of the groundwork and foundations could be carried out by local contractors, thus providing some economic, albeit short term, benefit. Once constructed and running, however, even the largest of wind farms would only require a small number of maintenance staff (3 or 4 in the case of Pentrefoelas) and many of these would be highly trained technicians with considerable experience, and unlikely to be local people. Only the landowners or farmers on whose land the wind farm was situated would benefit financially. Local people would not benefit from lower electricity charges, as the energy produced would go directly into the main electricity grid system. In total, the economic benefits coming from this form of alternative energy have been grossly overestimated, usually by those groups eager to promote wind energy schemes for short term profit.

In relation to the Pentrefoelas application, it could be said that a small number of jobs would be created, and that the turbines would be positioned some distance away from the nearest villages, but the fact remains, that in general, there is still considerable opposition to *onshore wind farms*.

Those groups opposed to the proliferation of wind farms point to the fact that their objections were 'based on a desire to preserve the landscape and a tourism trade worth £2.2 bn a year.' (NATTA 2001) While it is true that tourist destinations are now worldwide, a significant number of people spend time away from the large conurbations of the NW, walking, climbing, sailing etc in the Welsh countryside and in particular the National Parks. It is thought by groups opposed, therefore, that if large wind farms are sited in those areas most frequented by visitors, then this

would result in a considerable drop in trade. The same visitors do not consider them as an 'added attraction' but rather as an unnecessary eyesore.

viii) Two examples of conflicting interests

There were two other noteworthy items arising from the Pentrefoelas application.

a) At the time of the final proposal and subsequent refusal for this wind farm situated on the Hiraethog Moors, a Draft Environmental Strategy and Action Plan for the whole of the Hiraethog Area was being undertaken by the Environmental Policy Panel of Conwy's Countryside Service.

The plan was put before the County Council on 25th March 2002, having been initiated earlier in Sept. 2001, with the aim of 'enhancing the local environment and the special qualities of the area, whilst increasing its attractiveness to visitors and supporting the local economy through diversification and green tourism projects' (CCBC 2002).

A significant amount of local community consultation had already been undertaken in the preparation of the draft strategy and action plan. The project was supported by Conwy County Borough Council, the Countryside Council for Wales and somewhat surprisingly in the light of future developments concerning wind farms, Denbighshire County Council. Fifty per cent (50%) of the funding for the project was sought and obtained from the European Union Objective 1 money. Once the proposals were underway it was intended that a refined project list will form the basis of further grants for Objective 1 funding.

The study area is split approximately 50% in Conwy and 50% in

Denbighshire, including the community of Nantglyn---another disputed area. The importance of the area is indisputable in terms of its natural beauty, conservation value and a working landscape.

It is believed that 'enhancing the biodiversity, landscape and access opportunities will bring benefit to the local economy through agricultural diversification and green tourism.' Just as important, the Plan goes on to emphasise that the 'conservation of habitats and the characteristic landscape are considered to be essential to sustain *the economic potential* of the area.' (CCBC 2002)

It would seem, therefore, that the proposed Environmental Strategy and Action Plan, on which considerable sums of money were spent, would be at odds with an application for a large wind farm well within the designated area.

A further example of planning confusion can be illustrated next :-

b) Denbighshire County Council, a signatory to the original Action Plan, is now at odds with many of the long term aims and objectives of the Plan. When the original proposal for 28 wind turbines to be built on the site near Pentrefoelas, was presented to the council in July 1998, they were asked, as a neighbouring authority, to consider two different resolutions in relation to the original ideas laid down in the Plan, namely :-

i) That the proposed wind farm would not impact adversely on the land use, amenities, or interests of residents of Denbighshire, and offer no objections from this perspective.

ii) That the physical impact of the turbines could have an adverse effect on the local landscape and on the National Park, including the tourist industry, and concerns are expressed at the potential impact on the

Mynydd Hiraethog SSSI .

As a consequence, in June 1999, after careful consideration Denbighshire strongly objected to the proposals put forward by NWP on the basis of 'the likely impact on the local landscape and on the National Park and on the likely impact on the Site of Special Scientific Interest.' They continued to object when the application was downgraded to 26 turbines, albeit for different reasons.

Three months later on 22nd Sept. 1999, Denbighshire County Council themselves, received an application for a wind farm comprising 33 turbines at Tir Mostyn, Nantglyn. This site is approximately 6km to the east of the original site under discussion and well within the area covered by the newly proposed Environmental Strategy and Action Plan for the Hiraethog area.

On July 30th 2002, *in a complete about turn*, plans for what will be North Wales largest wind farm were given the go- ahead, the Welsh Assembly approving Denbighshire's decision to grant permission for the scheme. This decision makes no sense in the light of the long drawn out battle and subsequent failure to build at Pentrefoelas and the setting up of an area one step down from a National Park.

The successful company behind the scheme, Windgen Power, put forward the usual ideas that there would be economic benefits for the local community, including a contract for the fabrication of the towers by Cambrian Engineering. The scheme should provide electricity for approx. 15,000 homes -- though not necessarily in the immediate neighbourhood, since this would be fed into national grid system.

One month later, another decision by Wrexham Council,-- presumably

with the approval of the same Denbighshire County Council,-- was taken, which, in the light of the Tir Mostyn scheme, made no sense at all . An application by a farmer to build 3 turbines, each 60m high to the hub with an added 31m to the blade tip, at Cefn Coed, Glyn Ceirog was *rejected* by the council. The chief planning officer said “the council had received 1410 objections to the scheme and only 26 in support” (Daily Post 2002). In his report to the councillors he said that “ it must be acknowledged there are clear national, regional and local benefits to the development of renewable energy resources.”

However, the advantages of such a development have to be balanced against the harm that could be caused to the appearance of the area. He goes on to say “ it is considered that the proposed turbines would clearly have a *significant detrimental visual impact* on the unique and special character of the Ceirog Valley. The turbines would be grossly out of scale.” It was also thought that it could open the door to many other similar applications.

If these sentiments were given as a reason to oppose the application, then surely this would also apply to the even more sensitive area of Tir Mostyn. There are no records of the number of letters of support for this huge project. The rejection of this small scale proposal was in contrast to the site at Moel Maelogen, approved by Conwy CC and already up and running.

ix) Are offshore wind farms free from planning difficulties ?

Although offshore wind farms do have a number of advantages-- leaving aside the increase in construction and running costs-- this does mean, however, that considerable care and attention must still be given to the

choice of offshore sites. Along the Welsh coast there are several locations, which although eminently suitable for a number of reasons, are already designated as Heritage Coast i.e. areas of Conservation and Natural Beauty. A typical example was the proposal for a 30 turbine wind farm at Scarweather Sands off Porthcawl, South Wales. Although tourism is a key industry on this part of the coast, employing 18% of the local workforce, and despite a public inquiry planning inspector being against the scheme the Assembly's planning committee approved the proposal. A last-minute challenge in the Welsh Assembly was defeated and the order to build the wind farm was given. However, problems concerning the finances for such a large project have since meant that the farm will not be completed until at least 2010.

The public inquiry was the longest into a wind farm ever held in Wales, with thousands of pages of evidence considered. The inquiry inspector concluded that 'the visual impact of a wind farm in the specific location of this proposal would be so prominent when viewed from Porthcawl and its immediate area, that I consider that the harmful effects on this view are sufficient to outweigh the benefits of this proposal.' (BBC News/Wales 2004)

Friends of the Earth Cymru argued that there had been an over-emphasis in the public inquiry report, on the visual impact of such a development. These two opposing views illustrate what has now become one of the major factors in any new inquiries or future proposals. With the significant increase in the size and number of individual turbines, there has been a change in public reactions towards wind farms in general, from that noticed just a few years ago.

In many ways the decision in the Scarweather situation went against the advice given to local authorities in a consultation document published by the Welsh Assembly. (TAN 8 2004) When considering the methodology for the strategic assessment of the opportunities for major wind power capacity it concluded that ‘ a very large proportion of Wales is heavily constrained and not suitable for the development of large scale wind farms.’ Large scale renewable energy schemes of any type (and this presumably includes large tidal barriers) are not considered appropriate in internationally or nationally designated areas. However, both ‘within and outside the strategic areas, smaller, domestic or community based wind turbine developments may be suitable,’ subject to material planning considerations. Even though TAN 8 is only a consultation document, it is expected that many of the proposals contained in the document will be taken into account by local planning authorities in Wales when it comes into force.

What the example of Scarweather and other proposals does show, to some effect, is the degree of confusion and bureaucracy encountered by companies submitting planning applications. What is also obvious is the extent to which various organisations can bring pressure to bear on their own arguments, either for or against a particular application, simply because the policy statement and guidelines laid down by the Assembly are either too vague or simply not adhered to.

x) Summary of problems encountered and questions that arise from an example of a proposed wind farm site.

a) Inability of applicants to recognise the sensitivity of the site under consideration.

- b) Should areas already designated as areas for conservation be considered for development?
- c) Over reliance by the applicants on well presented, but badly researched presentation documents.
- d) A general disregard for the quality, and expertise, of those groups in opposition to the proposal.
- e) An over emphasis by groups supporting the proposal, on the possible economic benefits.
- f) The use of new government powers to push through unacceptable proposals -- targets must be met at all costs.
- g) Should the Welsh Assembly have the final say on all decisions?
- h) Little or no co-ordination between neighbouring authorities.
- i) Whether smaller, well organised sites (3 or 4 turbines) could prove to be more acceptable to the general public.

It is obvious, therefore, that the whole subject of planning permission has always been one which is riddled with difficulties for energy companies. That this situation has hardly changed is amply illustrated by contrasting the results of two recent (Sept. 2006) planning applications. One, a 12 turbine wind farm to be built within one of the seven designated areas in Wales, was given the go ahead and a second, for a 3 turbine *community based* wind farm, was refused (An outline of the two applications can be seen in Appendix 1)

Postscript:-

The widely held view that the wind energy industry as a whole would bring economic benefits to Wales was dealt a severe blow on August 10th, 2005, with the announcement of the complete closure of a turbine

tower factory in North Wales. Cambrian Caledonian (Camcal) Bangor, formerly known as Cambrian Engineering (Cymru), closed with the loss of 60 skilled jobs and future orders were to be carried out in Scotland. Over the previous seven years the company, under several different owners, manufactured more than 500 turbine towers and was expecting further new orders. Prior to 1998 the firm was involved in general steel fabrication but by 2004, encouraged by the prospect of a share in the newly emerging wind energy industry, 95% of its business was diverted into the production of towers, supplying the UK and Europe. However, because of serious delays in the sanctioning of new wind farm sites, especially in the UK, the expected orders never materialised. This was perhaps a case of putting all its eggs in one very dubious basket.

Conclusion

The common 'green' characteristics often portrayed by the general public does not always guarantee positive public views and support in all places and at all times. In his final conclusion on the 'public acceptability' constraint on the exploitation of theoretically available renewable resources, Walker (1995) maintained that 'there is still much scope for the dynamic development of both technologies and public attitudes and equally important the policy and planning context within which they interact.' In the decade since this study there has been considerable improvements in the technology of wind turbines, with the introduction of larger more efficient and quieter units but little progress has been made to understand the complex issues which surround public attitudes towards renewable energy. In fact, in the race to reach government targets for renewable energy, commercial exploitation and the 'science and

engineering' focus has overshadowed the need to develop a more sensitive and sophisticated awareness of public attitudes. Without this awareness, opposition will continue to grow, resulting in a significant reduction in government targets, which in turn will bring about compulsory orders for wind farms and a further escalation of the opposition.

The next section looks at some of the characteristics of the UK wind resource how and this may effect its relationship to energy demands.

In particular the author examines the theory put forward by the Environmental Change Institute (Sinden 2005) that a diversified wind system in the United Kingdom can successfully deal with any variable weather conditions which may occur throughout the country.

SECTION 4

A REVIEW OF PROBLEMS OF AND PROSPECTS FOR THE FUTURE OF WIND ENERGY

Until the late 1970s and early 1980s wind was not seen as a viable form of electrical generation in the United Kingdom. Beyond this time the increase in environmental concerns and an increase in state subsidies has led to a greater interest.

New environmental laws and guaranteed fixed prices for wind generated electricity, resulted in rapid advances towards this form of energy in several European countries, in particular Denmark and Germany, with Spain also becoming an important player. As a result of actively promoting wind power, Denmark now has the highest per capita installed capacity in the world and equally important dominates the world export market in wind turbines. The majority of turbines used in the UK are either imported or made under licence at the Vestas factory in Scotland.

The optimism surrounding the eventual impact of wind generated electricity must, however, be tempered by the fact that the resource is 'highly variable both in space and time, in the latter case on a daily as well as seasonal and annual basis. Moreover, these fluctuations and hence the expected availability of wind-powered generation, are only imperfectly predictable, and peak wind flows only rarely coincide with the time of highest demand.' (Smil 2003)

Many of the world's densely populated areas requiring large amounts of electricity-- and the UK is no exception-- are situated in areas which may experience long seasonal periods of calm weather with correspondingly

low wind speeds. In contrast, most of the best sites, chosen because wind generated electricity could be produced at the highest possible load factor and over sustained periods, are nearly always centred in thinly populated or uninhabited regions.

This often means the construction of long distance, high voltage lines, necessary to transmit power from such locations to regions of major demand. The construction costs of these lines would need to be included in the overall costs of new wind farms. Equally important is the siting of obtrusive power lines and pylons, coming on top of the difficulties encountered during the original application for any large scale wind farm development. Large scale wind projects are 'immediately helpful only in places where there are already major high capacity interconnections capable of transmitting both longitudinally (taking advantage of differences in peak demand) and latitudinally (taking advantages of seasonal differences in demand).' (Smil 2003)

The prime energy source, wind, is only broadly predictable and it is difficult to accurately forecast over long periods of time. Average annual wind speeds in successive years at the same site can differ by up to 30%. Even in areas considered to be generally windy there can be a twofold difference in total wind energy available for extraction from one month to the next. Prior to planning a wind farm development, wind speed measurements are taken over as long a period of time as possible. Because of the fundamental V^3 law ('the power in the wind is proportional to the cube of the wind velocity') any error in estimating the wind speed can produce a large error in the estimate of the energy yield. (Taylor 2004)

With, therefore, an accurate estimate of the possible wind speeds available at a particular site, the total amount of power that a wind turbine generates will depend mainly on the wind speed at any given time. At low wind speeds, the turbine is unable to generate electricity until the wind speed increases to the *cut-in*, at which time the turbine will begin to operate. Between cut-in and the *rated* wind speed the power output increases in proportion to the wind speed, until the maximum *rated power* the turbine is capable of producing is reached. This situation is maintained unless wind speeds are such that the turbine shuts down to protect itself from damage. (Fig.1) The actual amount of wind energy produced by a turbine over a given period of time is referred to as the *capacity* factor and is calculated as ‘the energy generated during a given period divided by the energy that would have been generated had the wind farm been running continually at maximum output’, ie :

capacity factor = electricity production during the period[kWh]

installed capacity[kW] x number of hours in period [h]

(Efficiency and Performance--Wind Energy Fact Sheet 14--DTI 2001)

Capacity factors are usually given as *percentages*, and the amount of wind energy produced by wind farms will, in general, depend on the seasons. Winter months are windier than the summer months in the UK and the average capacity factors for modern wind farms in the UK rarely achieve an annual capacity factor of more than 38%. (with a low of 28% in summer and a high of 47% in winter) Because of higher wind speeds, Scottish and Northern Irish wind farms usually generate more energy than those in England and Wales.

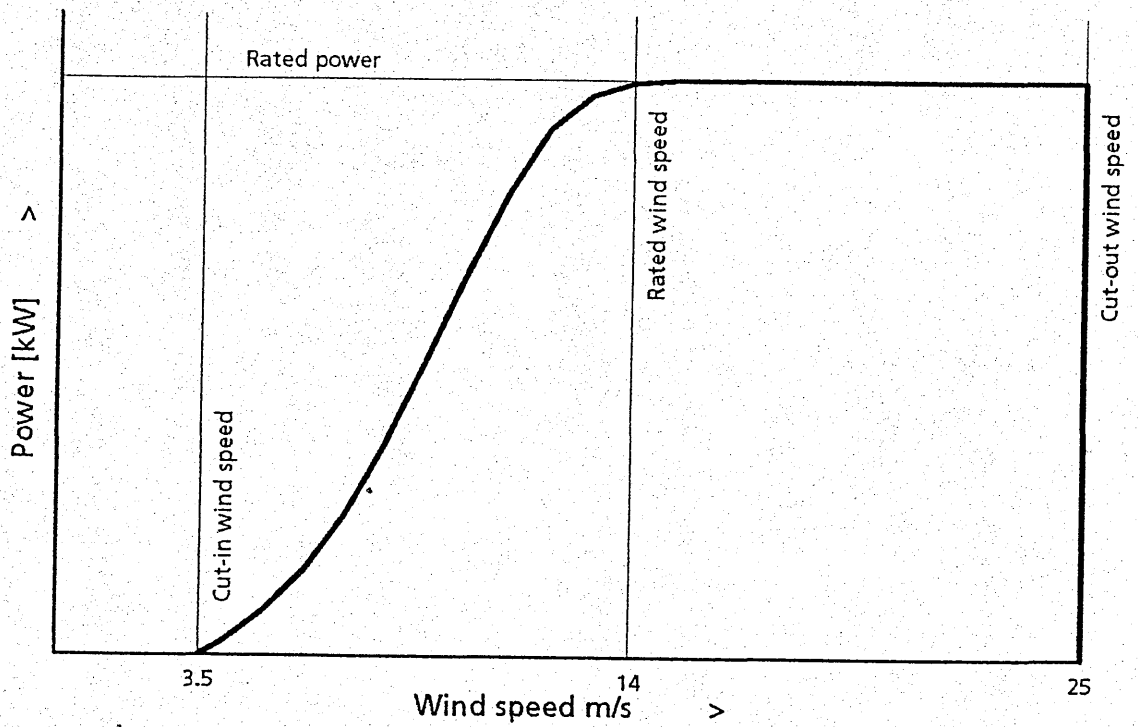


FIGURE 1- TYPICAL WIND TURBINE POWER CURVE,
SHOWING HOW THE POWER OUTPUT VARIES WITH
WIND SPEED.(DTI WIND ENERGY FACT SHEET 14 2001)

It follows, therefore, that figures quoted for newly proposed wind farms (e.g. 700MW from 200 turbines @ 3.5 MW) should always be considered with care, as in reality it may take twice as many turbines (i.e. 400) working at approx. 50% of the installed capacity to achieve such a target. In order to comply with current UK energy requirements, therefore, the number of wind turbines would need to be increased. The figures for the number of turbines needed to reach 10% of electricity from wind by 2010, varies considerably depending on which side of the argument you support. Coupled with the intermittency of the prime energy source are the problems encountered with safety considerations requiring modern turbines to cut out at wind speeds of around 25 m/s and power losses caused by blade soiling.

In a situation where electricity generated from wind energy is derived from a large number of wind farms, widely dispersed throughout a large land area and where a variety of weather conditions exist, then the intermittency of individual turbines becomes less important. This would obviously be the situation if North America and Canada were to embark on a large scale wind energy programme.

This may not, however, be the case in countries like the United Kingdom and Denmark where unsuitable weather conditions, either high winds or calm periods, can occur over large areas of the country at the same time. It is probable that the poor predictability of wind power will limit the use of wind energy to reach the required alternative energy targets, and sudden drops of 20-30% of output will have to be accommodated by other forms of energy. The effect of variable weather conditions and its

impact on intermittency is examined in detail in this section.

i) Characteristics of the UK wind resource: Long-term patterns and relationship to electricity demand.

A recent research paper produced by the Environmental Change Institute (Sinden 2005) has, it would seem, gone some way to refute the previous argument. On the understanding that the ability of wind power to reliably contribute to UK electricity is fundamentally related to characteristics of the UK wind resource, and how characteristics such as seasonal weather patterns correlate with electricity demands, they analysed the results of wind power output modelled from 34 years of hourly wind speed data from up to 66 onshore wind recording sites around the UK. This data was then matched to electricity demand data at a 1-hr timestep, thus allowing the long term relationship between electricity demand and wind power availability to be determined.

In assessing the long term characteristics of UK wind resource, Sinden used wind speed data collected by the Meteorological Office from measuring sites located throughout the country. This was in preference to using the recordings from single wind farm sites, since it was thought that wind characteristics differ between sites and for the purpose of a country wide assessment uniform data was necessary. This did not, however, preclude the use of single long term monitoring stations, used to obtain wind resource information for future wind farm developments.

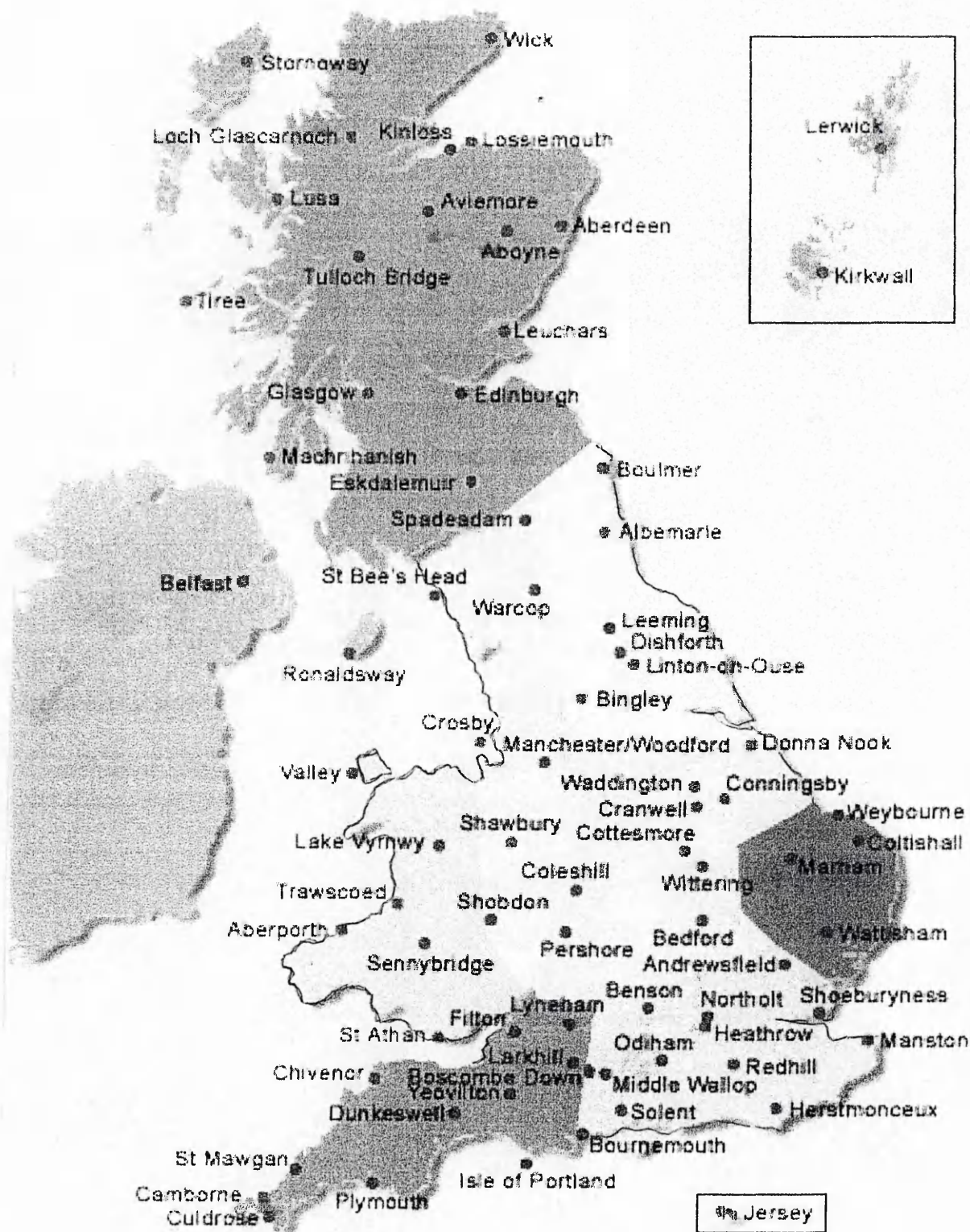
As Met. Office wind measurements are recorded close to the ground level (approx. a height of 10m.) an allowance was made for an increase in wind speed at 'hub height', typically around 80m. From the original 66 UK

sites a minimum of 45 sites were chosen, each site being classified on the basis of being either coastal, inland or island and located in southern, central or northern areas of the country.

This information was then used to examine the case for a diversified wind system; a system where wind turbines are located in a range of locations rather than being concentrated in one place. In this way wind turbines are exposed to a range of wind conditions in different parts of the UK, thus ensuring greater reliability and lower variability in an overall electricity system. Using these wind speed records Sinden identified a number of findings including the following:-

- a) Wind power availability is greater during winter than at other times of the year and is on average stronger during the day than overnight.
- b) Wind power delivers around two and half times as much electricity during periods of high electricity demand as during low demand periods.
- c) Whilst extreme lows or highs are a natural feature of the UK wind climate, a 'diversified wind power system would be less affected as it is rare that these extreme events affect large areas of the country at the same time.'(Sinden 2005) Equally important, it goes on to say that 'low wind speed conditions affecting 90% or more of the UK would occur in around *one hour every five years during winter.*' During these periods wind speed measurements of less than 4 m/sec would result in a zero power output.

An even more rare occurrence are the times when high wind speed conditions (over 25m/sec), a situation where wind turbines would have to be shut down as a safety measure affecting 40% or more of the UK, would occur in around one hour every ten years.



MAP 1. LOCATION OF WEATHER STATIONS

THROUGHOUT THE UNITED KINGDOM (MET. OFFICE 2006)

WIND AT 10 metre height (knots)

TIREE

Month

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
18.4	17.6	16.3	13.5	12.3	11.7	10.9	10.9	13.4	15.7	16.5	17.3	14.5

KIRKWALL

Month

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
16.8	15.8	15.6	13.3	12.0	11.3	10.8	10.7	12.9	14.5	15.2	15.6	13.6

LERWICK

Month

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
17.8	16.8	16.3	13.6	12.2	11.7	10.8	11.0	13.6	15.1	16.0	16.7	14.2

STORNOWAY

Month

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
14.2	13.3	13.1	10.9	10.2	10.1	9.4	9.0	10.6	11.9	12.1	13.2	11.5

TABLE 1 MEAN MONTHLY WIND SPEED AVERAGES FOR
'EXPOSED' SITES IN SCOTLAND 1971- 2000 (MET. OFFICE 2006)

WIND AT 10 metre height (knots)

ABERPORTH

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
16.5	15.4	14.8	12.0	10.9	10.3	9.9	10.5	12.2	14.2	15.2	16.1	13.1

VALLEY

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
15.6	14.0	13.7	11.4	11.0	10.7	10.3	10.6	12.2	13.6	14.2	14.9	12.6

TABLE 2 MEAN MONTHLY WIND SPEED AVERAGES FOR
'EXPOSED' SITES IN WALES 1971-2000 (MET. OFFICE 2006)

Although the original 66 recording sites (with a minimum of 45 sites providing the necessary valid data for each hour) included many coastal and inland sites throughout the UK, the use of this data in relation to actual wind sites can be misleading and not truly representative of the actual situation. Reference to the Met Office map of weather stations throughout the UK (Map1), indicates that many of these stations are situated in remote, exposed sites which do not equate to existing or proposed wind farm sites and which would have the effect of increasing the overall average wind speeds. These include such remote sites as Lerwick, Kirkwall and Stornaway in Scotland and Aberporth and Valley in Wales, where typical wind speeds are normally higher than those recording sites associated with inland wind farm sites. (Tables 1 & 2)

Sinden then went on to use the figures obtained from the Met Office to demonstrate that 'by diversifying the development of wind power sites, the variability exhibited by the aggregate output from the UK wind farms would be reduced', a situation which he describes as 'smoothing'.

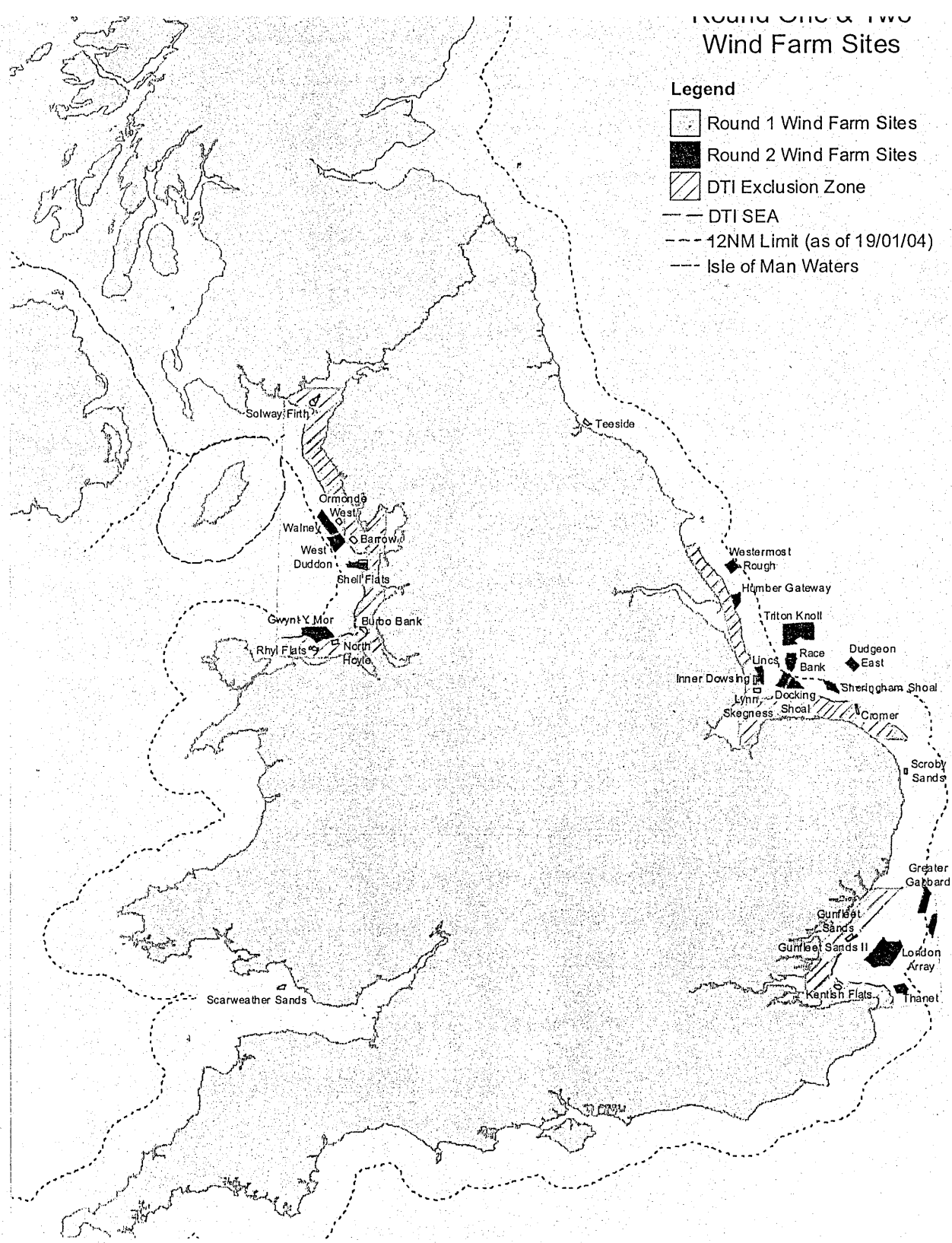
A key part to the 'smoothing' effect is the correlation between wind power patterns at different sites. It is assumed that no two wind sites will experience identical patterns of wind speed over the long term and that the difference in wind characteristics can be exploited to reduce the overall level of variability. The correlation between pairs of onshore wind sites, taken as a function of distance between the sites, decreases thus demonstrating that the further apart the sites the greater the 'smoothing' effect. Sinden does add an important corollary in that this 'smoothing' effect is limited by 'the area over which the electricity network extends--

once wind capacity has been installed at the most distant locations available on the network, additional capacity will exhibit higher correlation with the existing capacity as there is necessarily less distance between them.’(Sinden 2005) This may well be the case, since many of the existing wind farm sites in Wales and Scotland are situated inland at sites with lower average wind speeds and not sufficiently far enough apart to bring about a lower correlation.

Two further examples concerning proposals for future wind farm sites will also cast doubts on the viability of the ‘smoothing’ effect. The first is the decision by the Welsh Assembly to concentrate all future sites in seven designated areas, thus narrowing the distance between groups of turbines and with it a higher correlation factor. More importantly is the siting of the Round 2 offshore wind farm sites which are expected to provide a major part of the wind contribution to the figures for renewable energy by 2020. The majority of the proposed sites (Map 2) are positioned in a narrow band from west to east across central England with the London Array and several other smaller sites covering the south east. Whilst it is true that some of these sites are several hundreds of kilometres apart, they are all in an area where weather conditions may well be substantially the same at any one time.

Sinden also concludes that one of the impacts of ‘smoothing’ the results from a large number of sites is that ‘the change in power output from the UK wind farms would be less sensitive to changes in the UK average wind speed than would be expected from the power output curve of a single wind turbine.’(Sinden 2005)

Round One & Two
Wind Farm Sites



MAP 2 ROUND ONE & TWO WIND FARM SITES
(THE CROWN ESTATE JUNE 2004)

With this in mind, he considers two wind turbines in different locations hundreds of kilometres apart, with one experiencing wind speeds of 10m/sec and one experiencing speeds of 2m/sec, which would result in an average wind speed of 6m/sec. According to the theoretical power output curve, this equates to an average power output of only 253kw. However, taken individually, the high speed site has a power output of 1333kW and even though the low speed power output is zero, the resulting average power output of 667kW is substantially higher than that determined from the average velocity.

From this we can deduce that even if the wind speeds in one part of the UK are very low, higher wind speeds in another part of the country will compensate, resulting in the average power output being sufficient to maintain adequate energy supplies throughout the UK.

The theoretical result outlined above depends, therefore, on one of the recording sites regularly showing high wind speeds. However, when information is used from two recording sites many hundreds of miles apart but which happen to have similar average wind speeds and which also equate to existing or proposed wind farm sites, then the situation is less optimistic.

Examining similar figures for average yearly wind speeds from Dunstaffnage in Scotland with that of Shawbury on the Welsh/ English border (Table 3), would result in the former experiencing wind speeds of 4.56 m/sec (8.9 knots) and the latter experiencing wind speeds of 4.12 m/sec. (7.98knots) Theoretically this would result in average wind speed of 4.34 m/sec which equates to a power output of approx. 55-60 kW.

WIND AT 10 metre height (knots)

DUNSTAFFNAGE (SCOTLAND)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
10.6	10.3	10.1	8.4	7.7	7.4	7.1	6.7	8.1	9.0	9.9	10.1	8.9

SHAWBURY (WELSH BORDERS)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
9.0	8.9	9.3	8.1	7.6	7.4	7.2	7.1	7.3	7.4	7.9	8.6	7.98

TABLE 3 MEAN MONTHLY WIND SPEED AVERAGES FOR TWO
'DISTANT' INLAND SITES 1971- 2000 (MET. OFFICE 2006)

WIND SPEED AT HUB HEIGHT				POWER OUTPUT
m per sec	mph	km/hr	knots	kW
< 4	< 9	<14	4/6	0
4	9	14	7.5	15
5	11	18	9.7	105
6	14	22	11.9	255
7	16	25	13.5	440
8	18	29	15.6	675
9	20	32	17.3	985
10	23	36	19.4	1,330
11	25	40	21.6	1,690
12	27	43	23.2	2,020
13	29	47	25.3	2,315
14	32	50	27.0	2,500
15	34	54	29.1	2,500
16	36	58	31.3	2,500
17	38	61	32.9	2,500
18	41	65	35.0	2,500
19	43	68	36.7	2,500
20	45	72	38.8	2,500
21	47	76	41.0	2,500
22	50	79	42.6	2,500
23	52	83	44.7	2,500
24	54	86	46.4	2,500
25	56	90	48.5	2,500
> 25	> 56	> 90		0

TABLE 4 -- CONVERSION OF WIND SPEED TO POWER OUTPUT FOR A 2,500 kW WIND TURBINE (ENVIRONMENTAL CHANGE INSTITUTE 2005)

Allowing for the max. wind speed at each site (in January) this would only push up the power output up to approx. 120 kW. (Table 4)

It can be seen, therefore, it is more reliable to use wind speed data recorded over a number of months or even years, from a measuring site situated on or near the proposed wind farm. A recording tower which has been positioned at sea, close to the proposed Rhyl Flats and Gwynt y Mor wind farms, will provide more accurate data than that provided by Met. Office observations from Valley or Aberforth.

The second of Sinden's findings, that 'low wind speeds which affect over 90% of the UK are a rare event' is also open to debate. Wind speed figures from a total of 24 weather stations in Scotland and Wales i.e. weather stations which relate to actual wind farm sites (Table5) were examined over a period of 1⁰ days during late January and early February 2006. (Tables 6&7) During this period a high pressure system covered most of the UK, resulting in cold, misty weather with long periods of little or no wind, whilst at the same the demand for energy was higher than normal. Wind speeds were low, sometimes close to zero, in all but a few stations throughout Scotland and Wales and those with higher than average speeds were, in the main, situated in exposed sites.

If the wind speed figures for this particular 1⁰ day period are matched with a number of major wind farm sites in both areas, it can be seen that low wind speeds were occurring *throughout* the UK. The wind farms at Cefn Croes and Carno, two of the largest in Wales, were subject to low wind speeds during this period, as illustrated by the figures from the Trawscoed weather station.(Table6) At the same time wind farms at Black

WIND FARM SITES

Site	Capacity	No. Turbines	Nearest Weather Station
Roths	51MW	22	Lossiemouth
Black Law	97MW	42	Glasgow
Glens of Foudland	26MW	20	Aboyne
Hadyard Hill	120MW	52	Machrihanish
Pauls Hill	56MW	28	Aviemore
Causeymire	48MW	21	Wick
Cruach Mhor	30MW	35	Tulloch Bridge
Beinn an Tuirc	30MW	46	Tulloch Bridge
Cefn Croes	58MW	39	Trawscoed
North Hoyle	60MW	30	Valley
Carno	34MW	56	Trawscoed
Llyn Alaw	21MW	34	Valley

TABLE 5 MAJOR WIND FARMS EITHER 'LIVE' OR 'UNDER CONSTRUCTION' IN SCOTLAND AND WALES BY THE END OF 2005 (BWEA) IN RELATION TO THE NEAREST WEATHER STATION

WEATHER STATIONS IN WALES

Aberporth *	10	14	9	2	4	11	11
Lake Vyrnwy	8	9	5	0	0	7	0
St. Athan	7	14	16	10	7	10	6
Sennybridge	7	8	9	5	N/A	N/A	6
Trawscoed	7	0	8	0	5	0	4
Valley *	10	11	12	3	6	0	0

25th 27th 29th 31st 2nd 3rd 4th
Jan. Jan. Jan. Jan. Feb. Feb. Feb.

TABLE 6 WIND SPEEDS IN KNOTS OVER A PERIOD OF 10 DAYS
2006 (MET. OFFICE UK WEATHER OBSERVATIONS 2006)

* Denotes 'Exposed sites'

WEATHER STATIONS IN SCOTLAND

Aberdeen	7	12	9	0	3	3	2
Aboyne	4	6	2	4	0	0	6
Aviemore	5	4	1	1	1	1	5
Edinburgh	6	6	5	8	3	1	6
Eskdalemuir	10	9	2	3	2	2	1
Glasgow	7	3	3	2	1	2	2
Kinloss *	5	5	7	1	1	2	8
Kirkwall *	8	4	11	5	7	12	22
Lerwick *	10	4	13	9	3	13	7
Leuchars	4	7	5	13	5	3	8
Lock Glascarnoc	7	N/A	4	0	0	4	0
Lossiemouth	7	8	8	1	1	6	13
Macrihanish	11	6	8	8	7	5	5
Skye Luse	2	3	5	7	3	3	7
Stornoway *	9	6	13	18	6	8	12
Tiree	4	N/A	N/A	14	15	5	7
Tulloch Bridge	1	3	6	0	0	0	1
Wick	8	6	7	9	6	4	14

* Denotes 25th 27th 29th 31st 2nd 3rd 4th.
'Exposed sites' Jan. Jan. Jan. Jan. Feb Feb. Feb.

TABLE 7 WIND SPEEDS IN KNOTS OVER A PERIOD OF 10 DAYS
2006 (MET OFFICE UK WEATHER OBSERVATIONS 2006)

Law, Hadyard Hill and Pauls Hill in Scotland were subjected to similar weather conditions, based on figures from the Glasgow, Machrihanish and Aviemore weather stations.(Table 7)

There are further examples of how:-

- a) wind speeds in Wales and Scotland can occur in parallel over a set period of time.
- b) wind speeds can occur at their highest or lowest over a number of days, at *any time* of the year and that the transition from high to very low takes place over a short space of time.
- c) wind speeds recorded at remote weather stations in both Scotland and Wales are not representative of the overall weather situation used to estimate energy output from wind farms --especially during periods when most inland wind farms maintain a steady output but where developments situated in more remote areas would close down.

Further examples can be seen in Tables 8-11 (Appendix 2) which show wind speeds occurring over Scotland and Wales during the period late November to the end of December 2006.

In his research, Sinden also identified that ‘in general the long term pattern of wind power availability results in limited electricity production in summer-- when it is expected that *demand is at its lowest*-- and greater than average production in winter. On average wind power is expected to deliver around twice as much electricity during the winter months of December, January and February as it does during the summer months of June, July and August.’ (Sinden 2005)

If, however, the UK is faced with long periods of high pressure in the

summer, during which there is little or no wind and when electricity demand is unusually high because of power surges arising from the increased use of air conditioning plant and 'white' goods, including fridges and freezers as is the case in the United States, then wind power can not be relied upon to supply a major part of this increase in demand.

Using the figures for wind speeds (knots) for the period 15th June to the 22nd July 2006, relating to the weather stations in Scotland and Wales previously examined in Tables 6&7, it was again found that the wind farms currently in service in these areas would not have played a significant part in electricity demand. A maximum wind speed of 26 knots (30mph) was registered between the 12th-13th July at Lerwick which would have given a power output of 2400kW from a nominal 2500kW (2.5MW) wind turbine. When matched with a corresponding site in Wales this would have resulted in a satisfactory low correlation. However, by the 14th July the figure for wind speed was much lower and over the *whole* period the figures for all the weather stations were-- with one or two minor variations-- never more than 17 knots (20mph) and this included such remote stations as Kirkwall and Aberporth. This example again illustrates the inherent variability of wind energy and any substantial drop in energy output would mean that an equivalent increase in output from conventional power stations was necessary in order to meet the surge in demand.

Recent investigations have also shown that blade soiling, caused by large numbers of insects caught on the leading edges of turbine blades, can cause considerable power losses. At the same time those turbines

positioned in exposed areas for maximum efficiency may, ironically, be most affected by the accumulation of ice and dirt on blades, which again could bring on sudden power losses. This effect could, however, be kept to a minimum by the use of de-icing fluid on the blades, similar to that used to avoid the build up of ice on aeroplane wings.

What is most important is that if, as a consequence of global warming, long range forecasts of weather patterns indicate much longer periods of very unsettled weather both in winter and summer, then the situations outlined above may well become the norm rather than an occasional event.

ii) 'The impact of intermittent generation on the UK electricity network'--
two independent assessment reports, one German the other British.

The fact that wind forecasting is inaccurate and that as a consequence electricity generated from wind energy fluctuates greatly has previously been outlined by the author with respect to Scotland and Wales. A number of reviews outlining this situation have recently (2004-2006) been published in the UK and abroad which either uphold this view or put forward a more optimistic picture.

In the annual Wind Report for 2004 published by the German energy firm E.ON Netz, it expresses the opinion that 'many of the UK's national policy expectations for wind energy are currently unrealistic.' (E.ON 2004) E.ON Netz GmbH is a major electricity grid operator in Germany. As a company, they can realistically be said to know more about the practical realities of managing a large wind carpet in a modern grid system than many other organisations in Europe. Based on figures for 2003 the Wind

Report identifies a number of key operational challenges, which whilst referring to the situation in Germany, can equally apply to the United Kingdom.

The report acknowledges the fact that the level of wind power infeed fluctuates greatly depending on the prevailing wind strength and that the quality of wind power forecasting, essential for a *stable* grid operation, is to a great extent limited by the quality of weather forecasting. To this end, E.ON has over several years used a complex forecasting system based on data supplied by the German Meteorological Service, which while being as accurate as possible is still prone to substantial deviations.

Despite this up-to-date system, figures for the whole of 2003 (Fig 2) shows how electricity generated from wind fluctuated greatly, with the result that electricity demands had to be covered by traditional power stations, a situation which incurred extra costs. The chart shows how the contribution made by wind power production varied between zero in real terms and just under one third of the grid load. The annual wind infeed curve (Fig3) also shows how the maximum installed capacity was rarely reached and that over half the year, the wind power fed-in was less than 11% of the total wind power capacity.

Equally important is the fact that wind power infeed changes can occur in a relatively short time, whilst at the same time only a limited number of power stations are capable of being brought up to full power on time in order to meet the required energy demands. E.ON found that 'both cold wintry periods and periods of summer heat are attributable to stable high-pressure systems' (E.ON 2004) The resulting low wind levels means that

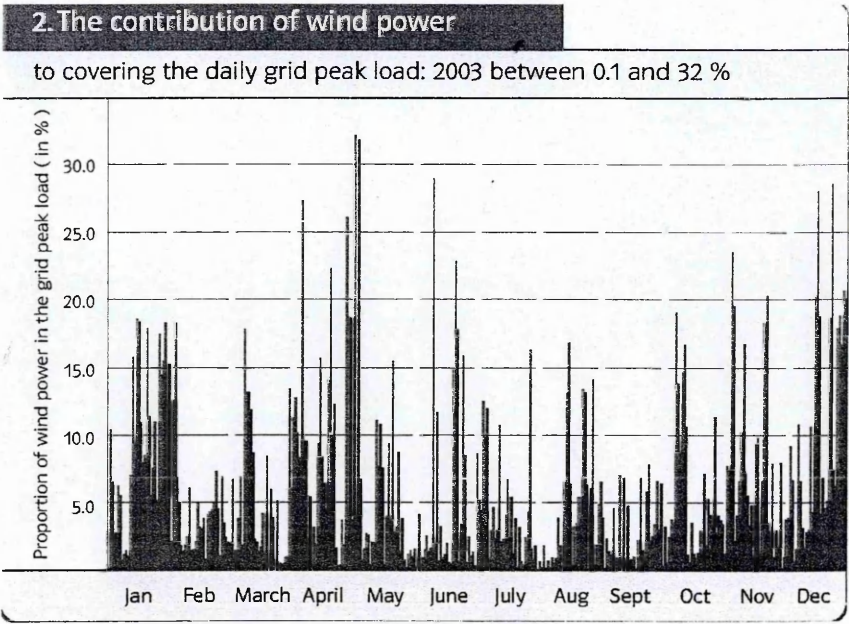


Fig 2 The contribution of wind power during 2003 in E.ON control area showing fluctuations (E.ON 2004)

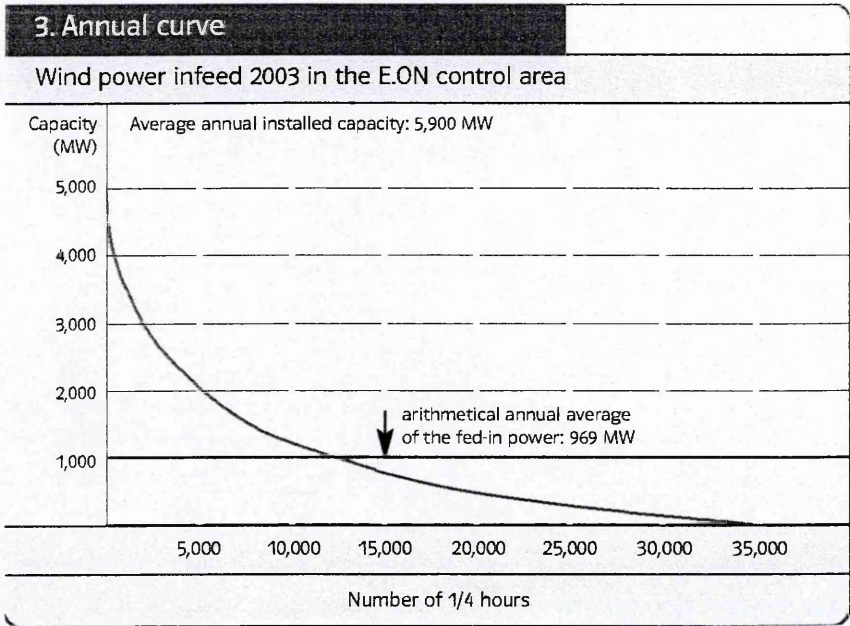


Fig 3 Wind power infeed 2003 in the E.ON control area

in these periods, the contribution made by wind energy plants to covering electricity consumption is corresponding low. Alternatively, periods of strong winds are often interspersed by a drop in the wind strength which also places an extra burden on conventional power stations to maintain energy demands. In two examples, both of which mirror those outlined by the author in a previous section, the E.ON report shows how wind power changes can occur sharply over a period of days during which time conventional power stations would be on constant standby.(Fig 4) Equally important is the fact that as well as fluctuating over a period of days wind power infeed changes can occur in a relatively short time. (Fig 5)

During a heatwave in July/August 2003, German electricity consumption was well above average, resulting in an increase in demand from the whole of the electricity supply network. However, as a result of the heatwave, wind power production was very low due to a lack of wind and as a result was not able to contribute in any substantial way to the strained supply situation. Similar situations have already occurred in the UK and if the forecast of considerable changes in weather patterns is confirmed, (including hotter summers) then this may well be a regular occurrence.

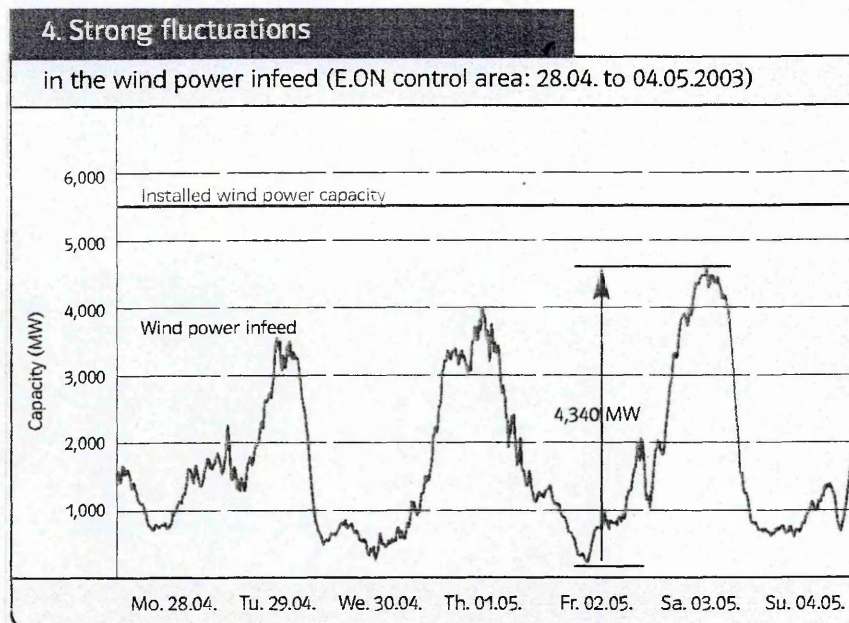


Fig 4 Fluctuations in wind power infeed over a period of 4 days in the E.ON control area (E.ON 2004)

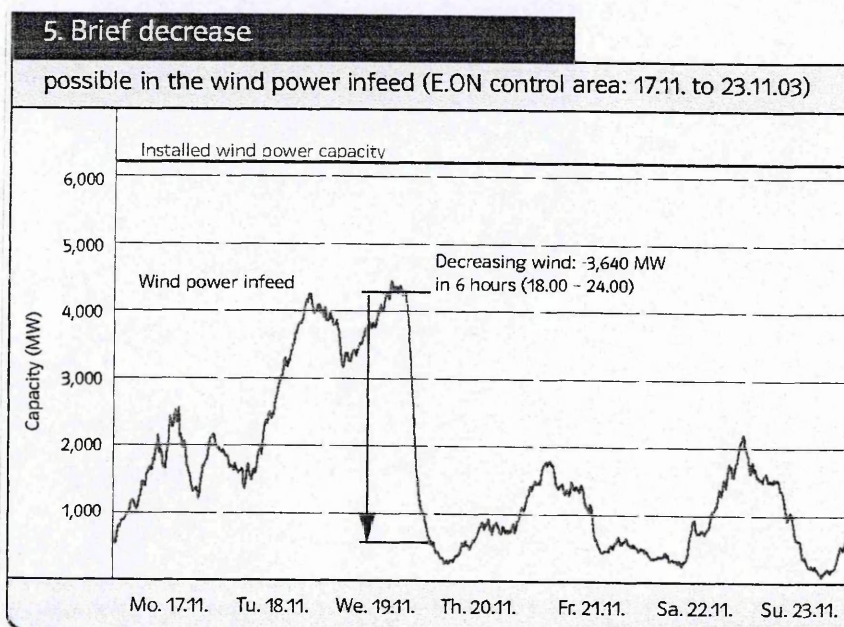


Fig 5 Effect of rapid decrease in wind power infeed over a 6 hour period in the E.ON control area (E.ON 2004)

In a report by the UK Energy Research Centre (UKERC 2006), some of impacts of intermittent generation on the UK electricity network have been analysed, the results of which differ in some ways to those of E.ON. In the introduction to the report it acknowledges the fact that it is based on a review of over 200 international studies, very few of which suggest that 'introducing significant levels of intermittent renewable energy generation on to the British electricity system must lead to reduced reliability of electricity supply'. (UKERC 2006) It does, however, emphasise that care must be taken when comparing studies of intermittency from one country to another, or from one system to another. This must surely be a self evident fact, since comparing 200 studies would inevitably involve examples from all over the world, including those countries e.g. USA where electricity networks cover large areas, each with its own weather patterns.

The report outlines some of the factors which need to be taken into consideration when comparing the impact of intermittent generation.

The quality of this particular renewable energy will, naturally enough, depend on the strength of the wind and the degree to which it fluctuates. Coupled with this is the case for better weather forecasting. Better forecasting can improve the efficiency with which intermittency is managed and with this in mind it was assumed that weather patterns in some regions are more predictable than in others. Evidence from the E.ON report suggests, however, that even with the most modern computer equipment, weather forecasting is not always reliable and the degree to which it becomes so, is some way off.

If then, 'weather forecasting can be improved, wind farms are geographically dispersed in order to obtain the maximum output, and the electricity grid and capacity to transfer power from generators to consumers is available, then theoretically intermittency will not be a problem.' (UKERC 2006) The report maintains that some of the conditions in the UK, including the quality of wind resource, robustness of the grid and relative late gate closure will, it is hoped, tend to mitigate the impacts of intermittency and keep associated costs low.

It does, however, add a note of caution in that the current lack of interconnection and the relatively small geographical area over which resources are dispersed will tend to increase the costs of managing the system. The problem of dispersal of wind farms throughout the UK is fundamental to the problem of intermittency and can not be improved on, and as previously mentioned, may well be made more difficult with the siting of the Round 2 offshore wind farms.

Although the report suggests that comparison between the UK and other countries must be treated with the greatest of caution, the comparison with the situation in Germany covered by E.ON is entirely relevant. Geographically, the areas under consideration are in many ways similar and weather patterns which occur over southern areas of the UK are often the same as those over the near continent. Only in the far north of Scotland and the Orkneys, Hebrides and Shetland Islands can the weather be sufficiently different to theoretically overcome the impact of intermittency in the UK as a whole. However, most of the existing wind farms in Scotland are situated in areas where the weather patterns are not

dissimilar to those in Northern England and Wales and the proposals to site very large wind farms on some of the islands has met with opposition, as is the proposal for 181 turbines on the Isle of Lewis.

In conclusion the report conceded that it 'was international in scope but draws out the key findings relevant to the British electricity network' and in doing so maintained that 'none of the studies reviewed in our assessment suggest that intermittency is a major obstacle to the integration of renewable sources of electricity supply.' (UKERC 2006) It goes on to say that 'it is neither necessary nor appropriate to allocate dedicated back-up or reserve plant to individual renewable generators when these are integrated into modern electricity networks', but that there major impacts and costs through connecting increasing amounts of intermittent supply into 'system balancing actions' and that there would be a need to install or maintain capacity to ensure reliability of supplies.

In the final analysis they make several recommendations for policy and further research. Intermittent generation can make a valuable contribution to energy supplies, but to ensure reliability of supply investment in thermal capacity is also required and what this means is that new, more appropriate generating plant will be required to replace older plant. In this context, the report questions the implications of different combinations of thermal plant under consideration at the present time by the government, on the costs and impacts of integrating renewable energy into the system. In particular, the 'relative impacts of different sizes and types of thermal generation, and of inflexible versus flexible plant.' (UKERC 2006) This issue assumes a greater importance with the announcement by the present

government, to proceed with the building of up to 10 new nuclear power plants by 2020, a form of thermal generating plant particularly 'inflexible' when it comes to integrating wind energy into electricity system.

On the subject of 'smoothing' i.e. reducing the degree of fluctuation, the report suggests that the ideal situation, in which there is a wide geographical dispersion of wind farms coupled with the relevant corresponding interconnection between regions, would reduce the overall costs to the system. It does acknowledge, however, that in some countries wind development has clustered in specific geographical regions (and this is certainly the case in the UK) which has resulted in problems for the system operators. It goes on to say that some of the literature being examined *assumed* wide geographical dispersion and where this does not occur the impacts of closer geographical clustering along with the relevant cost issues need to be better understood. In relation to this, the proposals for much larger individual wind farms, including those offshore, will present a series of new problems concerning fluctuations in supply.

iii) Intermittency--what effect it can have on the shaping of public support for wind energy in the UK.

The two conflicting reports from EON and UKERC, both of which require a technical insight into the problems associated with wind energy, illustrate the dilemma of how best to describe intermittency to a public increasingly doubtful about its effectiveness.

A research paper by Devine-Wright et al explores how intermittency is communicated to the public by campaign groups either in favour or against wind energy. Public opinion continues to play an important part

towards achieving those targets set by the government for alternative energy.(Something which is examined in greater depth in the next section) Whenever any new large scale wind farm development is proposed the key issues affecting public acceptance are how the visual, acoustic and environmental impacts will affect the area in question. Those organisations involved in the development of wind farms go to great lengths to persuade the public of the benefits of wind energy, usually through lengthy enquiries and lavish exhibitions. At the same time, civic groups opposed to these developments counter the benefits put forward with arguments of their own, backed up by an array of technical details put forward by scientists and engineers sceptical about the true worth of wind energy.

In their research Devine-Wright et al maintain that the debate amongst experts about problems associated with the increased deployment of intermittent renewables has 'not taken place in a vacuum, but has occurred alongside ongoing social controversy over proposed wind farm developments in the UK.' (Devine-Wright et al 2006)

Although intermittency is seen by many as a significant factor in the acceptance of wind energy as an alternative energy form, it is perhaps the one issue which the public is least able to understand- and for a good reason. Research studies of the public perception of intermittency found the subject was communicated in various ways including 'reliable/unreliable' or 'fluctuations'. Whatever the terms used to classify the problem, they found that there was a problem in the way 'intermittency is communicated to the public in such a way as to present arguments either

supportive or sceptical about the impacts of particular renewable energy technologies.’ (Devine-Wright et al 2006) This has left a wide gap between ‘expert’ and ‘lay’ knowledge, a situation which is often exploited irresponsibly in order to further arguments for or against. In trying to identify aspects of intermittency they found that ‘whereas the public could easily identify with the scale and visual impact of wind turbines, there were no images of intermittency because it is a time-dependent effect which cannot be readily conveyed in a static image.’ Even that section of the public who are in regular contact with or have at least seen a large wind farm do not always realise how the amount of electrical energy generated depends on the weather. The blades are either turning at a steady number of revolutions or not at all. Few are aware of the relationship between the wind speed and electrical energy-- not unless they have a bicycle with a dynamo fixed to the back wheel, where the faster you pedal the brighter the light!

In summarising their results Devine-Wright et al suggest that ‘intermittency is already an issue being debated in the public realm in the UK and used to influence local acceptance and resistance to wind energy development.’ This being the case, why then are there ‘challenges to the UK government attempts to legitimate the energy policies and ensure the local acceptance of the renewable energy developments, despite frequently cited results of opinion polls suggesting a widespread public support.’ (Devine-Wright et al 2006)

In relation to this latter conclusion the overall findings did suggest a need for further research into how intermittent renewable energies is being

represented to the public and the manner in which national policy on climate change is communicated at community level. National policies promoting intermittent renewables may need to be more vigorously communicated at the local level where development actually takes place, using local interested and trustworthy parties rather than national institutions.

iv)BalancingRenewables--the need for alternative back-up energy systems

If, as we have seen, there is an element of doubt in that widely spaced wind farm developments can smooth out some of the variations inherent in this form of renewable energy, then there will always be a need for back-up energy systems.

The rapid development of wind energy has resulted in a problem of how best to integrate such a source into a National Grid system which in itself is required to cope with very large variations in demand. The existing National Grid system relies on large generating plant, justified on the basis of economies of scale, centralised control and distribution and capable of meeting almost all demands made on it. Recent energy crises in America and the UK have shown, however, that even these long established systems have been stretched to the limit.

The *normal* run of fluctuation in energy demands can be satisfactorily dealt with. If, however, there is a sudden increase in demand caused by an unforeseen event, e.g. a rapid drop in temperature, a breakdown in a large power station or even the televising of a major sporting event, then the system is 'managed' to prevent a breakdown occurring. Traditionally this problem has been dealt with by bringing on line a fossil fuelled power

station generating electricity at part load or held in reserve. Running power stations in this manner reduces their efficiency and wastes fuel; they are more efficient when run continuously.

The problem of maintaining back up energy sources will become more acute, as coal fuelled power stations reach the end of their working lives over the next decade, and as proposals are put forward to run down ageing and environmentally undesirable nuclear power stations. However, even if the nuclear power stations were fully operational, they are not the ideal solution since they can not be brought up to full power quick enough to compensate for any interruptions in supply.

It is estimated that over the next 10 years, investment of £50-£70 billion will be needed to bring on line new combined-cycle gas turbine (CCGT), combined heat and power (CHP) and clean coal generation facilities along with the refurbishment of the power infrastructure. Demand for power is outstripping supply and world energy demands is expected to rise by two thirds between 2003 and 2030. Whilst demand in the UK will not reach these levels, there will probably be an appreciable increase. It should also be noted that any move towards gas powered stations will bring with it the risk of gas supplies being interrupted or even stopped when relying on sources in Russia or the Middle East.

If renewable energy sources are, therefore, to be relied on to produce an increasingly greater percentage of the countries future energy needs, then more advanced and environmentally friendly forms of replacement generators or storage units need to be developed and constructed.

A range of technologies currently exist, either to store electricity, or to

bring in extra generating capacity at peak times. Pumped storage plants have been in use in the UK for over 20 years, two of which are situated in Wales. At times of sudden peak demand they can use the stored potential energy of water that is contained in high level reservoirs to generate electricity in a matter of minutes. Dinorwig power station, opened over 20 years ago, is regarded as 'one of the most imaginative environmental projects in the world' and can respond in minutes to very large surges in demand for electricity.

Despite being a seemingly ideal situation for sudden surges in demand there are no plans to duplicate this form of power station. Indeed, even the future of this power station and one at Ffestiniog was in doubt for some time, until the recent purchase (July 2004) by International Power of both stations from the previous American owners. However, since the plant produces electricity for both the National Grid and other major industries in Wales, closure would result in serious problems of supply.

Two smaller hydroelectric power stations at Dolgarrog and Cwm Dyli are run by Innogy Hydro, the UK's leading electricity generator, and together they can produce 45MW of electricity. The original development at Dolgarrog was carried out in 1907 by the then Dolgarrog Aluminium Corp. to provide power for smelting aluminium. Since 1989, over £10 million has been invested by the company in replacing and refurbishing plant at both stations and they will be capable of producing electricity for the National Grid for another 60 years. (Innogy 2004)

Both power stations lie entirely within the Snowdonia National Park, but it should be noted that they were there before the park was formed-- it is

doubtful if such major projects would be considered at the present time.

A major problem associated with the introduction of any future hydroelectric plant would be the cost and time taken to bring on to line. Opened in 1984, Dinorwig was a multi-million pound project then and took 10 years to complete. Although modern engineering techniques may reduce the time taken to build a similar plant, the costs would be considerably higher at present day prices.

What should be taken into account, however, is the fact that 'the combined peak output of the two plants in Wales (Dinorwig and Ffestiniog) and one in Scotland is over 2GW, about 5% of the UK's typical winter electricity demand. Typically, such plants have an overall storage efficiency of 70-80% and can be brought to full power in minutes.' (Boyle 2004 p.399)

There is a strong parallel with the construction of any new generation nuclear power stations, that is the prohibitive cost and length of time to completion. Both technologies do, however, have the best means of overcoming the major disadvantages associated with some forms of renewable energy.

The technology also exists to store energy in rechargeable batteries, both lead acid and sodium sulphur batteries, currently used in vehicles, but these have a limited life and are expensive to replace. They are in limited use in a number of countries, including a 12MW unit at the TVA's Mississippi plant, (Smil 2003) but most have inbuilt disadvantages and could not be used on a large scale.

Off peak electricity can also be used to store compressed air in

underground caverns. The compressed air is then fed into gas turbines thus reducing their gas consumption by 60%. A large (2.7 GW) plant planned for construction in Ohio, USA, will compress the air to over 100 atmospheres. This technology could be used in the UK, as in Cheshire for example, where extensive redundant salt mines could be used. However, since these mines are situated below large built up conurbations there would be strong objections to such plans. Similar plans to store natural gas underground has met with considerable planning difficulties from objectors living close to the proposed plant.

To reiterate, the main disadvantages of renewable energy when compared with traditional means of generation would appear to be

- a) long term backup of renewable electricity.
- b) the distribution of this energy at all times and during times of high demand.

Whilst a number of promising ideas have surfaced in the design of large scale batteries for electricity storage, none have been successfully developed. There has been little emphasis in designing either 'high-density, high-efficiency, low-cost batteries for smaller applications or inexpensive high-power devices that would fit the multi-MW to GW-sized systems of modern electricity generation.' (Smil 2003) A number of flow battery systems similar to the abandoned 'Regenesys' system, which used two different liquid electrolytes contained in tanks, have also been developed.

Since wind turbines do not have the capability of storing the energy produced, how and when this wind -generated electricity can be absorbed

into the National Grid operation is open to question. In the case of the amount of wind energy produced, it is expected that the diversity of supply i.e. the result of the difference of wind patterns across the UK, will help to smooth out the varying total demand on the National Grid. The author has, however, referred to doubts about the reliability of this solution, especially with regard to future unstable weather patterns. This problem is made worse on the occasions when there are 'days with no wind power'. Whichever question is addressed there will be a need for a backup from other energy sources and extra grid links, all of which incur extra expenditure. What should also be taken into account is the conclusion that 'small amounts of generation from intermittent sources such as wind power create insignificant extra system costs, but that these increase with the proportion of electricity from intermittent sources. (Boyle 2004) It can, therefore, be safely assumed that if the government's target for a substantial increase in the amount of renewable energy from wind power by 2020 is to be met, then a reliable, low cost, backup system must be in place.

In the next section the author looks at the public's perception of wind power, aspects of the debate on its uses as an alternative energy source, the increase in the public's awareness of the technology involved and how some of the problems resulting from the proposed increase in wind farm development can be resolved. Even though surveys have generally shown strong overall public support for wind power, many proposals have either been delayed or simply rejected. It was initially thought that the NIMBY syndrome was a barrier to successful development but more recent events

have indicated that, when confronted by actual developments, public support has declined. Extracts from planning proposals, council minutes and studies seeking to explain the apparent variations in public attitudes have all been examined.

SECTION 5

THE PUBLIC PERCEPTION OF WIND POWER

Since the first wind turbines were first introduced into the UK, there has been considerable debate as to how the general public would perceive this 'new' form of energy generation. Whilst it has always been universally accepted that alternative energy in the form of wind turbines would produce no CO₂ and emit no particulate matter or acidifying gases into the atmosphere, environmental and aesthetic objections have continued to grow.

America was one of the first countries to experiment with large scale wind energy generation, however, since the late 1980s Europe, in particular Germany and Denmark, have taken the lead. The first wind power site in America opened in 1980 at Altamont Pass and consisted of 200 50kw turbines-- tiny when compared with today's 4/5MW giants. At that time, many Americans considered that wind farms, because of the way they dominate a large, otherwise natural landscape, exposed the way people thought of undisturbed nature as a myth. Robert Thayer of the University of California-Davis considered that 'their development (wind farms) challenges many notions that everyday Americans have about "scenery".' (Asmus 2001) The siting of nuclear and fossil fuel plants in isolated areas of the country, far from the centres of population, perpetuates the belief that nature can remain inviolate from human activity. In this way we remain unaware of the environmental impact of our demand for ever increasing amounts of electrical energy.

Thayer conducted extensive research into how people responded to

Californian wind farms. When given the choice of a number of ways of generating electricity, including nuclear power stations, most opted for wind power. When, however, the research moved from the abstract concept of a wind farm to seeing the actual spinning turbines in place on the Altamont Pass, reality set in and the responses became more and more negative. Thus we encountered the first signs of the dilemma caused by the visual impact of wind farms on hitherto unspoilt scenery. His research showed that as people who lived closer and closer to the Altamont Pass were questioned, responses became more and more negative.

In his summing up of how future wind farms will be perceived, he maintains that since turbines are a function of the variability of nature i.e. the wind, then these same turbines will become 'part of the landscapes' appropriateness, clarity and comprehensibility. In the long run, wind energy will contribute highly to a unique sense of place.' (Asmus 2001)

The suggestion that these machines imbue a place with a unique value (an idea which has been increasingly put forward to support proposed onshore wind farms in the UK) is something which does not always go down very well with many consumers, as the author will try to show later. It is far too abstract an idea and in reality it is rarely found to be true. Thayer's research did, however, find that if wind power was inevitable, then future developments should be made up of fewer and larger turbines arranged in orderly and uniform arrays, and that way wind farming's acceptability would grow. This idea has, to some extent, come to pass, but Thayer probably would not have envisaged the size and number of turbines proposed for current wind farm developments. As such, we may

have reached a point where the public's acceptability will begin to wane. His research concluded that 'technology quickly becomes a lightning rod sparking a sharp debate about different kinds of environmental values. When it comes right down to it, wind farming is all about very deep questions of balance, the hard part is properly weighing everything.' (Asmus 2001)

Public attitudes towards wind power and the factors that influence the outcome of onshore windfarm planning applications in England and Wales have been the subject of much research in the last decade.

Before looking at several actual examples in the UK, the author reviewed two research papers which examined the outcome of planning applications and the methods involved:-

i) The assumption is that wind power will provide the bulk of the UK governments targets for renewable energy deployment. Toke (2005) maintains therefore, that the key to a successful outcome for these targets is to examine the factors that influence decision making, with special reference to England and Wales. In his research paper, Toke considers the part played by various participants in the planning application and how much influence they have on the final outcome.

It is important to note at the outset, that wind power schemes are subject to exactly the same planning machinery as other developments in the UK, except that they often tend to be much more controversial. Developers apply in the first instance to the local planning authorities, after which there is a planning consultation involving the planning officer, various levels of councillors, the local public and a standard list of representative

bodies. In the event of a refusal developers may ask for a Public Inquiry, with the inevitable cost in time and money. An important development was that wind power schemes above 50MW would be subject to a final decision by the DTI, although the local council would make a recommendation. It is likely that in the near future, government powers to make the final decision will be further increased in order to reach alternative energy targets.

Toke looked firstly at the role played by councillors and the planning officer in the final outcome. Councillors on Development and Control Committees can be influenced to a considerable degree by the planning officer, especially where the possibility of a refusal would result in a costly Public Inquiry. At the same time, the impression gained from this study was, that despite the pressures and lobbying from interested parties, a great many councillors would be influenced by what they perceive to be in their electoral interests. There will be 'an element of responding to strongly held views coming from people who you regard as supporters' especially if they represent voters directly affected by a particular development. (Toke 2005)

Well organised local anti-windfarm and landscape protection groups such as the CPRE or the CPRW can effectively lobby councillors at both parish and planning authority level. At the same time the results of this research suggest that wind power developers do have a very big influence on the outcome of planning decisions. A number of developers have offered economic inducements to local communities which they hope will overcome opposition, but the majority however, do not see the necessity

to employ extra public relations staff in order to communicate with and understand the feelings and aspirations of the local populations.

Another important factor which arose from the research was that concerning the the perceived negative impact on tourism, something which can be seen in a number of recent applications in Wales. The evidence tends to 'suggest that at the very least it is difficult to separate out landscape factors from economic factors. It seems that economic factors play a major role in assessments of whether landscape or pollution reduction values are given greater prominence in planning decisions.' (Toke 2005) There are already in existence throughout Wales, enough wind farm developments to be able to monitor any negative impact, if any, on the tourist trade which plays an important part in the Welsh economy.

In conclusion Toke reinforced the oft held view that 'decisions by local planning authorities in England and Wales to refuse planning permission to wind power schemes are closely associated with high levels of apprehension about such schemes among people living in the immediate vicinity of the proposed sites.' (Toke 2005) Government planning policy will play an increasingly important part in eventual outcomes but there are limits on the extent to which Government can imprint its will on local councils. Whilst wind power developers can rightly argue that the planning framework in its current form impels them to spend a great deal of time and money on applications, it is also clear that the majority of developers do not 'engage in the local political activity that seems to be influential in British conditions.' (Toke 2005)

Conversely, it is often the case that the more the developers involve local people the less likely they are to accept a project.

ii) Ellis et al (2006) looked at why earlier research into the nature of objection to wind farms in the UK proved to be inadequate and at times even counterproductive.

Previous research 'tended to provide descriptive rather than explanatory insights and as a result, has not effectively informed the policy debate. One explanation is that much of this research has been conceived within a positivist research frame, which is inadequate in dealing with the subjectivity and value-basis of the public acceptance of wind farm development.' (Ellis et al 2006)

Earlier research into the nature of public acceptance of wind farms, public attitudes and the attempts to identify the barriers to acceptance, including the perception of specific impacts (acoustics, visual etc.) has been almost entirely empirically driven and, as such, has tended to deploy two main types of methodology -- opinion polls and case studies of specific wind farm developments, with the latter also using market research type questionnaires. (Examples of these two types, used for actual wind farm developments in Wales are examined in detail later in this section.)

Having rejected this form of research, later studies have established that public perception of wind farms was 'indeed a multi-dimensional phenomena constituted through a range of complex cultural, contextual, socio-economic, political and physical factors.' (Ellis et al 2006) Of these, the strongest impact was that posed by the projected aesthetic of the turbines and the perceived impact on the landscape -- something which

will continue to be the most difficult hurdle to overcome.

Some research maintained that the way forward is through 'education or awareness-raising.' Objection to a particular development is often formed not by experience, but rather by ignorance, misinformation, prejudice and fashion, something which indicates the urgent need for 'reliable' information.

Even this concept has its detractors, since there is little evidence of any correlation between knowledge of wind power and its acceptance. Indeed as it has already been pointed out, many objectors, and this can include so-called NIMBY groups, are sufficiently well informed about all issues to be able to bring about a powerful case for rejection.

By contrast the position held by supporters has not always been subject to scrutiny-- there are many examples where supporters recourse to using unsupported and often misleading information to further their case

In the search for a greater understanding of how public acceptance is constructed with respect to wind farm proposals and in order to test Durnings (1999) claims for the Q-Methodology (a study of human subjectivity) test, Ellis et al used this approach to examine the controversy surrounding the first offshore wind farm in Northern Ireland, the Tunes Plateau proposal.

Whilst this approach could be applied to any wind farm proposal, it was seen that whilst offshore schemes provide a strategic opportunity for the wind energy business and may well represent the future of wind energy, they are under-researched, particularly in terms of the type of public reaction they elicit.

It was found that 'like other examples of wind farms, this proposal displays a number of tautological characteristics in terms of the pattern of support and objection.' (Ellis et al 2006) Thus, the Northern Ireland population has been quoted as the most supportive of wind farms projects within the UK and until recently onshore proposals have attracted little opposition. Yet in the case of this offshore proposal, where it could be expected that the remoteness of the location would attract less opposition, there has been considerable opposition from a range of individuals and organisations in both Northern Ireland and in the Republic of Ireland.

In conclusion Ellis et al stated that:-

- i) The understanding of the motivation to either object or support a wind farm proposal defies simple explanation.
- ii) Producing precise and quantifiable answers to what are, ultimately, matters that reflect deep values and convictions has led to a system which dominates the thinking behind all wind farm applications.
- iii) Such a system is often used to subdue opposition to wind farm proposals.
- iv) The most popularly deployed methodology used in this system, the opinion poll, has been discredited and has contributed to the impasse in understanding public perception of wind farms and renewable energy in general.

The effectiveness of the use of Q-Methodology as applied in this case suggests that 'it can not only contribute to the wider issues, but can also deliver the prerequisite knowledge for developing more deliberate responses that may in turn, deliver a settlement of differences to any

disputes.’ (Ellis et al 2006)

Public attitudes towards wind power in the UK have centred around changes to visual appearance of the landscape. Comparisons are often made to other structures in the landscape, for example Nelson’s Column, the BT Tower or Canary Wharf. Such comparisons could be seen as ambiguous at best or even meaningless, since comparisons should be made with existing structures likely to be found within the compass of the proposed wind turbines. Comparisons should be made with the huge electricity structures used to carry the National Grid cables or television and telephone towers, rather than three examples of tall structures to be found in London. These are taken out of context and the effect most unlikely to be seen-- not unless they build a wind farm in Hyde Park.

In reviewing public attitudes the general argument that ‘much of the pressure against wind power projects has been marshalled by a few vocal anti-wind farm groups,---who believe that the visual appearance of wind turbines is not appropriate to the British countryside’ has prevailed. (Taylor 2004)

A number of surveys have been carried out in the UK in order to resolve public attitudes towards wind power. Much credence has been given to the results, but it should be noted that much of this work has been carried out by the British Wind Energy Association (BWEA), a group which should not be seen as totally impartial. A survey carried out by Ipsos in June 2003 on behalf of BWEA (Ipsos 2003) which involved 2600 UK ‘household bill payers’, concluded that 74% of those questioned were supportive of wind energy with only 6% against whilst the majority of the

remainder were neither for or against. This could not possibly be seen as a truly representative survey group, since many would be urban householders with little or no concept of what was involved in the construction of a large multi turbine wind farm in a rural setting.

In a summary of 42 separate surveys carried out between 1990 and 2002, the BWEA concluded that 'whilst 77% of the public were in favour of wind energy, only 9% were against.' (BWEA 2004). It could be argued that the surveys carried out in the 1990s were based on the results from a small number of unobtrusive wind farms which were in complete contrast to the proposed multi unit wind farms involving giant (up to 4MW) turbines positioned on sensitive sites.

There has also been considerable confusion over future energy costs and energy bills when this form of renewable energy becomes readily available. With the construction of the North Hoyle wind farm, nPower suggested in a promotion, that their 'clean, green electricity generated by the natural power of the wind' would only cost the same to the consumer as nPower's 'normal' electricity. This is only partly true, since as a result of the Renewables Obligation scheme, supply companies are obliged to obtain a certain proportion of their electricity from renewable sources, the cost of which is borne by the consumer but that this would only increase electricity bills by a small amount each year. They went on to say that because nPower is one of the UK's largest energy providers, it could even cost you less than your existing supplier. In general, this has proved to be somewhat disingenuous, as green energy providers have taken advantage of rising oil and gas prices to increase environmentally minded customer's

bills along with those of their regular customers. A number of companies selling hydro-electric and 'wind farms of renewable energy have increased charges by up to 10 per cent.' (Daily Telegraph 18th Oct. 2004)

Taylor quotes the results of a recent investigation (TNS, 2003) commissioned by the Central Office of Information, which found that 'less than 20% of those surveyed would be resistant to a wind farm being developed in their area'--- a figure significantly higher than the 9% produced by the BWEA. It goes on to say that 'almost two thirds (ie 66%) of the General Public agreed that they would be happy to have a renewable energy generating station built in their area.' (Taylor 2004)

This type of survey appears then, to produce a positive response towards the construction of future wind farms. At the same time, however, the planning system-- which can involve an element of public participation through exhibitions and inquiries -- is beginning to turn down some recent developments. What is not clear, is what part public attitudes play in the outcome of any individual planning application. There is a considerable element of inconsistency where on the one hand, a seemingly large proportion of the population are *generally* in favour of wind energy, whilst at the same time when it comes down to *individual* developments there may be considerable opposition. It may be that a detailed examination of a particular development, highlights some of the disadvantages often overlooked in much of the hype surrounding wind energy.

The rate of construction of large onshore wind farms deemed necessary to meet alternative energy targets has not always been maintained and

some projects have been turned down whilst others lacked financial support. Throughout this period there has remained a considerable hardcore of opposition to new proposals despite some evidence to suggest there is general support. A greater realisation of the environmental damage which might be caused, the belief that wind energy is seen as a flawed and unreliable source of energy and the politicisation of the so called Nimby groups, all contribute to this effect.

As previously mentioned, plans for a wind farm on Saddleworth Moor near Oldham have been rejected and more importantly proposals for what would have been one of the largest wind farms in England, that situated along the Whinash Ridge. It was planned to build 27 wind turbines, each approaching the height of Blackpool Tower, along a 5 mile ridge situated between the Yorkshire Dales and the Lake District National Park. The final decision was made by Malcolm Wicks, the energy minister, who agreed with the planning inspector's argument that 'the impact on landscape and recreation would outweigh the benefits in terms of reducing carbon emissions.'

As reported earlier, in Wales plans for a large wind farm at Scarweather Sands -albeit an offshore wind farm-- have been put back for a least 2 years, and plans for the construction of several small wind farms in the Strategic Search Area (SSA) A, defined by the Welsh Assembly as an area suitable for wind farm development, have met with considerable opposition.

Development will be limited to just four zones within this area, with a potential total wind turbine capacity of 196MW. The main zone is situated

within the Clocaenog Forest (115MW), for which both Conwy and Denbighshire councils are responsible. It has been estimated that to accommodate the 30 or so turbines, a large number of the trees in the forest (mainly coniferous) will have to go. Since large wooded areas are said to capture significant amounts of carbon dioxide, removing the trees to accommodate wind turbines might well have a negative effect on the eventual reduction in carbon emissions. However, since the energy companies submitting these proposals will almost certainly appeal in every case, any wind farm with a capacity of 50MW or over may well be pushed through, despite mounting opposition.

One interesting fact was that the owner of the land at Whinash would have received £150,000 a year in rent from Chalmerston Wind Power. Little has been said about the size of the financial incentive being offered to landowners to allow wind turbines to be built on their land. Many are farmers wishing to diversify away from farming, some are councils with large tracts of unproductive land (financially), whilst others own large estates (as at Whinash), part of which could bring large rewards for very little input. What is certain is that most of these decisions are not entirely altruistic in character, with little or no concern shown for the well being of people living nearby. It is also the case that the need to provide for renewable energy sites is not uppermost in any decision made by landowners, rather that it is a purely financial one.

Finally, an examination of perhaps the most recent NOP survey commissioned by the DTI (May 2006) found that 'despite all the hot air and scepticism from certain quarters, (something which used to be put

down to NIMBYism) 81% of the general public were in favour of wind power and just over three fifths would be happy to live within 5km of a wind power development.'

It is unreasonable to suggest that over 60% of the population would gladly live within 3 miles of a large onshore wind farm. Since turbines are usually sited in relatively remote and exposed areas where they can make the maximum use of the prevailing winds, then it is likely that only a few scattered cottages and farmhouses would be affected in any way. There is evidence to show that where wind turbines have been positioned close to more heavily populated areas and where official assurances led the public to believe that their fears were groundless, the final reaction has been less than sympathetic.

Surveys in themselves, do not always answer a number of important questions, which taken together, may slow down or even halt the development of certain wind farm proposals. These questions include :-

- a) The effects of constantly upgrading government targets for renewable energy, in particular those put forward by the Welsh Assembly.
- b) The increasing problems associated with balancing environmental/conservation concerns, with those encountered by businesses and industrial organisations employed to fulfil the same government targets.
- c) An increasing awareness of the advantages and disadvantages of wind energy shown by sections of the population when opposing the proliferation of uncoordinated and badly planned major wind farm developments, both onshore and offshore.
- d) If and when surveys need to be carried out, then questionnaires

should be constructed in a balanced way, rather than favour one or other of the protagonists.

e) Recognition that even countries with well established renewable energy programmes, e.g. Denmark, have to overcome an increasing number of problems concerning the use of large areas of land, environmental problems within these areas and local planning issues and to what extent can the UK learn from their results.

i) A closer look at two of the issues outlined above.

Research has led to the belief that 'groups often accused of being selfish and parochial are sometimes engaged in progressive community action against planning authorities that are too influenced by particular, often private, interests.' At the congress of the International Geographical Union held in Glasgow (2004), delegates concluded that such groups, often referred to as Nimbys ('Not in my back yard') can sometimes be a force for good that prevents bad planning and protects rural communities.

Whilst the *broader interests of the community as a whole should be paramount*, informed and progressive Nimbyism can often prevent poor planning decisions and act in the interests of local democracy. Protests groups are able to act as a counterbalance to those in public office, be it governments, local authorities, energy companies or private individuals, who were unduly influenced by specific, often private interests.

The problems encountered when setting new targets for wind energy are not confined to the UK. In Denmark the increased size of modern wind turbines is posing new challenges for both local and regional authorities. New planning guidelines are needed to replace the present outdated versions, in order to consider locating new large wind turbines without

disregarding environment and landscape. Whilst there are still many suitable sites in Denmark -- mainly on the coast-- and national goals should be met, new developments must be linked to local planning policy.

The Danes acknowledge the obvious fact that wind turbines, modern versions of which can be 100-150m tall, will always be visible in the landscape --especially so in a comparatively flat landscape such as Denmark. If, for example, they are located to blend in with the surroundings, there may be too many obstacles blocking the wind and thus efficiency is impaired. Since modern turbines have a lifespan of 20 years or more, long term planning is essential.

In a paper produced by Steffen Damborg concerning “ Public Attitudes Towards Wind Power” (Damborg 1998), his initial reaction to surveys was that ‘they had often not been performed according to scientific standards and that there is little coordination between the studies.’ This makes it difficult to make cross country analysis. Damborg found, however, that as a result of surveys undertaken in Canada, Netherlands and Denmark, close on 80% of the people questioned were in favour of wind power as a means of renewable energy. From 1990 to 1996 thirteen research studies had been undertaken in the UK with similar results to those shown above. Consideration has to be given to the fact, however, that at this time wind power was in its infancy. Only a small number of wind farms existed in the UK and the turbines were significantly smaller than today's giants. One can assume that, almost ten years on, these figures would not necessarily translate to the present situation.

Damborg outlined a study (1997) undertaken in the municipality of

Sydthy, Denmark, an area with 12,000 inhabitants and where 98% of the total electricity consumption can be covered by wind power. Sydthy had one of the highest concentrations of wind power in the world. The results of an opinion poll undertaken at the time indicated that since the population had considerable experience of wind power, they were more positive about this form of renewable energy than those with little or no knowledge. There were however, a number of *totally unexpected* outcomes which in the present climate seem difficult to believe. The distance to the nearest turbine had no effect on people's attitude towards wind turbines in general. One result showed that 'people living closer to the nearest wind turbine than 500 metres tend to be more positive about wind turbines than people sited further away from the turbines.' (Damborg 1998) Yet another result indicated that the number of actual wind turbines in the locality had no negative influence on people's attitude towards wind energy.

What was paramount in all these results was that people who own shares in a wind co-operative are more positive about wind power than people who have no economic interest in the subject. Wind co-operatives have been an important part in the successful development of wind energy in Denmark, unlike the UK where they have played no part in a system which is countrywide based.

Damborg also considered the Nimby syndrome as applied to Denmark (1995). As in the UK, there was a general acceptance that there is a considerable difference between wind energy as a concept and wind turbines as acceptable structures. It was seen that people support the

general idea of renewables and wind power but when it comes to actual projects in a local area, the acceptance of wind power seems to vanish. It should be said, however, that the Nimby syndrome is not confined to wind power, many other new constructions can face resistance at local community level.

A later study (1997) carried out in Germany indicated that the size of a particular wind turbine project, with regard to both the size and number of turbines, was not necessarily the biggest influence on the eventual public attitude towards the project. What was more important was the public's attitude towards the developer, local decision makers and the eventual decision process. The study suggests that a 'participative approach in the siting procedure has a positive effect on the public attitude towards the project, and thus leads to a decrease in public resistance. What matters is the *involvement of the local population in the siting procedure, transparent planning processes, and a high information level.*' (Damborg 1998)

Whilst in general this principle is one which should still be adhered to, paradoxically, the expansion of the wind energy programme over the last six years has led to a change in attitude and a gradual increase in public resistance. Much more information about planning applications for new wind farms, those organisations concerned with the actual development and the likely effect on the local community and environment is now available to an increasingly informed and sceptical public.

ii) The Awel Aman Tawe Community Wind Farm Project--2001

One of the first major attempts to involve local people in the planning of a wind farm scheme in the UK was carried out at Awel Aman Tawe, South Wales, in 2001, as part of the DTI Sustainable Energy Programme. The House of Lords Select Committee in their report on Renewable Energy (1999) considered that it was 'vital that urgent steps were taken to cultivate better public understanding of the issues and to create a more favourable climate for new proposals'.

At the time this Participatory Assessment Process (PAP) was seen as a pilot project designed to develop and test a range of methods and approaches which could be used in future community consultation programmes. Whilst it was hoped that the lessons learned from this particular project could be duplicated on other wind farm proposals, it should be noted that Awel Aman Tawe would consist only of 4 or 5 turbines rated at between 2 and 2.5 MW, hardly comparable to future developments possibly consisting of 100 or more turbines each rated at up to 4MW each.

This particular project was seen as being similar to many of the small Danish community led wind farms and the assessment process was designed with this in mind. Although nearly 9000 people were involved in the actual process it was never-the-less parochial in its scope and it is unlikely that this type of assessment could be upgraded for use where the number of turbines involved was numbered in the tens or even hundreds, covering large areas of land or sea.

The AAT Project was divided into three stages, which consisted of the

main aspects of consultation, information dissemination, discussion and debate and finally decision making. At the end of nine months of consultation the Electoral Reform Society administered a community referendum. Out of a total of 8,810 ballot papers distributed, 4,246 papers were counted, resulting in a total turnout of 48.3%. Whilst this result was above average for any referendum, it did show that over half of the population were either undecided or not interested. The figures for the overall result were also inconclusive, with 57.5% voting for the wind farm and 42.5% voting against. Within this overall result there were some widely differing outcomes when the figures were broken down into those from individual villages.

In much the same way as the Danish equivalent, people living in the 12 closest villages and farms could become a member of the community project and as such would benefit from a charitable trust set up to manage all profits from the electricity generated. Such funds could go towards generating new local jobs and develop community facilities and services, both economic and environmental. This then, was seen as the way forward for future wind farm developments, where the advantages would outweigh the perceived disadvantages.

Five sets of criteria were identified that local residents should use in judging the merits of this particular project:--

- a) The potential threats of the wind farm to local livelihoods.
- b) Whether the people involved are trustworthy.
- c) Opportunities for the wind farm to benefit the local area.
- d) Environmental factors. e) The consultation process itself.

It is important to emphasise that all of these criteria would apply to any project under consideration today, especially with regard to the large multi--turbine wind farms currently seeking planning permission. There would, however, be a greater emphasis placed on the potential economic and financial opportunities to be gained from the project e.g. the number of long term jobs and the possible financial incentives. It is equally important that the consultation process should be thorough and unbiased with equal weight given to both sides of the debate, regardless of any preconceived ideas. The final decision should be made by local authorities rather than central government, having taken into consideration the wishes of those people most closely involved, as well as striving to meet the goals set by the renewable energy lobby. It should not be made for purely financial reasons outlined by a small number of farmers and landowners, encouraged by major energy companies.

There were several important factors arising from the survey which influenced the eventual outcome of this particular project-- factors which were peculiar to this part of Wales but which would not necessarily be duplicated elsewhere in the UK.

Up to the 1980s the area under consideration ie AAT, boasted a high level of employment and a broad range of facilities. Where once there were numerous traditional sheep and cattle farms, a coal mining and steel industry and allied manufacturing factories, by 2001 much of this had gone or was in decline, or in the case of farming badly affected by foot and mouth disease.

The introduction of renewable energy in the form of wind farms was seen

as a viable opportunity to halt the gradual loss of livelihood opportunities. Over 70% of all respondents to the questionnaire considered this to be one of the most important aspects of the proposal. This figure increased significantly in those areas where farmers saw this as a means of making a move towards diversification away from farming. Employment was perhaps the major factor in the consultation and even at this early stage most people looked to assess this new venture on the basis of possible new jobs. Comments made by the respondents were written down and included both sides of the argument. “We have put up with the coal (open cast mining) because we got work from it. What’s the point of this wind farm if it’s only going to make a few jobs ?” (AAT 2001) Those supporting the idea looked at the potential employment through the environmental education centre or other spin-offs relating to the wind farm.

During the consultation period many of the older villagers remembered decisions which were made about local open cast mining, where community benefits were talked about which never came to fruition. At the time open cast mining was overwhelmingly rejected, but the development went ahead regardless and as a consequence a large percentage of those questioned thought that this would happen again. The final decision whether to build or not would be taken at a higher level, regardless of any doubts or fears that may arise from the survey. A few even suggested that the survey was merely a cosmetic exercise to show that the majority were in favour of the development.

These views expressed in 2001, have been amply reinforced by a recent

decision (8th Dec 2004) to resume opencast mining at a similar site in the Swansea Valley. A Welsh Assembly planning committee has given the go ahead for 2.1m tonnes of coal to be extracted from the East Pit site at Ammanford over the next 7 years. As always there were advantages and disadvantages to the scheme. Supporters claim it will create up to 140 much needed jobs at the pit, whilst opponents say it will be a blight on the community and have a detrimental impact on the environment. At the official level, Neath and Port Talbot Council welcomed the application to extend operations, whereas neighbouring Carmarthenshire Council was among the objectors. One local villager commented that 'Cwmllynfell has suffered 57 years of opencast mining already. *Coal belongs to the past.*' The final remark does ask the question why such a large amount of coal would be needed, when the remaining deep mines are being closed and coal fired power stations are being phased out, as part of a major drive to cut greenhouse gas emissions. The only clue to the resumption of mining is that the coal to be mined is prime anthracite, which presumably can be exported at a considerable profit.

One important view expressed by some of the respondents in the AAT project was one where they were supportive of small community based wind farms, but they were apprehensive that this may be the thin end of a very large wind farm wedge. Once the original development was up and running 'would that be the catalyst for many more larger wind turbines to be built in the same area in the coming years.?'

As in the previous example this particular fear can be demonstrated in relation to the wind farm site near Moel Maelogan, above Llanrwst. As

previously outlined this was originally a small community wind farm, consisting of 3 small turbines erected by local farmers as a means of diversification from sheep farming. The company formed by the farmers have recently obtained permission to build another 9 or 10 larger turbines, despite considerable opposition from a large number of local people who have had the opportunity to live with the existing turbines for several years and who do not wish to see the numbers increased. Over a thousand people protested to Conwy County Council claiming the 'region is turning into an industrial power station, with echoes of bygone years when large areas of Wales were flooded to provide water for the Midlands.'

With planning permission already obtained, the farmers will presumably have no difficulty in obtaining the money to complete the £10 million scheme, since most of the money will come from investment bankers. At the same time the only local people to benefit, will be the farmers who have already made considerable financial gains.

The AAT study of the processes which influence people's opinions included the part the media played in any decision making. Coverage of this particular project in local newspapers and on Welsh television was examined and it was found that it contributed substantially to the level of discussion and debate about the wind farm. Whilst it was true that there was a certain amount of misinformation, in general it was decided that the media in all its forms helped to shape people's opinions. It also showed that although renewable energy, and in particular wind farms, was both desirable and inevitable, there was always a need for every new proposal to be examined carefully and not just passed through 'on the nod'.

Conclusions :-

The AAT report concluded that the consultation was a valuable exercise, in that, in general, a majority of local people were in favour of the project and that they supported the idea of a wind farm. It also claimed to identify, perhaps more contentiously, benefits and opportunities for the local area. The consultation also aimed to raise awareness of the positive impact that renewable energy could make at a wider level, in relation to the reduction of pollution and possible environmental benefits. It is important to note, however, that to many people, these issues were not uppermost when reaching a decision and were regarded as secondary to the outcome at a local level. There were a few local residents who had a greater awareness of the issues regarding environmental sustainability and climate change, possibly through contact with earlier wind farm developments.

At a brief first glance then, it would seem that the results from this survey reflected similar outcomes from most of the previous surveys carried out in the UK and abroad. Such a positive outcome would be welcomed by those energy firms in favour of renewable energy and could be seen as a justification for the construction of future large scale wind farms.

What is not taken into account, however, is the fact that in a referendum in which less than 50% of the community actually voted, a significantly large proportion of those taking part voted against the project. It could be said, however, that although Wales is the most anti wind area in the UK (or even EU) obtaining a 57.5% vote in favour was an encouraging result. Notwithstanding this, it was obvious that even in 2001, this form of

renewable energy was not as widely accepted as those pressing for a greater commitment to wind farms would have us believe. In previous years a somewhat unconvincing argument was put forward, as to the economic, financial and environmental benefits to be derived from wind energy. However, with the benefit of hindsight, an increase in relevant information and a greater understanding of all the advantages and disadvantages, attitudes towards this form of renewable energy have changed. This is particularly so when consideration is given to onshore developments. The successful completion of the North Hoyle offshore wind farm may signal a more positive attitude towards wind energy, but even then there will be certain reservations

It is also useful to look at two further studies of public perception released in 2004.

iii) Climate Concern -- 'Attitudes to climate change and windfarms in Wales.' The Welsh Consumer Council -- Sept. 2004.

In March 2004, the Welsh Consumer Council and Friends of the Earth Cymru carried out a Wales-wide survey to investigate three items of concern. First, they wanted to gauge levels of concern about climate change among the Welsh public, second, how human activity was responsible for this change and third, people's attitude towards windfarms across the whole of Wales. This survey was in the form of opinion poll studies of general belief and an examination of perceptions of specific developments-- a methodology which has since been criticised as being unreliable and lacking in depth. (Ellis et al 2006) The results obtained regarding the subject of climate change demonstrated the unreliability of

this type of survey. Whereas ‘two-thirds of respondents (66%) said they were “ fairly or very concerned” about climate change, just over a quarter (28%) said they were “ not very concerned or not at all concerned,”and one in twenty (6%) did not know. From these figures the survey then assumed that 42% were “fairly concerned”, indicating that many people may see climate change as a threat, a result which was entirely subjective in nature.

On the subject of climate change, it was clear that although a large proportion of people would appear to accept that climate change was a fact, the findings of this survey demonstrated that ‘knowledge does not always translate into action.’ (Bibbings 2004) More than half of motorists knew that their cars contributed to climate change and that one third also considered air travel as a major factor (in reality a surprisingly low figure), but that this knowledge was not enough to change their attitude towards these forms of transport.

As climate change becomes an ever increasing subject in the media, the problem ‘may end up seeming so enormous that people will retreat into apathy, concluding that there is little point in them doing anything about it.’(Bibbings 2004) There is also a strong tendency for people to conclude that there is no point making an effort to change the situation, if others lack the will and a sense of collective responsibility to assist in bringing about this change--- for example the reluctance of the US to ratify the Kyoto Protocol. This was seen as a key issue in the opposition towards the proliferation of windfarms in Wales, a country that produces only one-tenth of the 2% of UK emissions. People need to be convinced of ‘the

efficacy of large scale collective action to climate change'.(Bibbings 2004)

As far as wind energy is concerned, the survey resulted in mixed reactions from those who took part. Nearly half of the sample was supportive of windfarms on land (45%) and more than half was supportive of marine windfarms (55%). However, at the same time only 22% were very supportive of windfarms in general- from which we can assume that they didn't mind where they were built. To further complicate the results, another section of the survey concluded that there was a large minority of people who were still undecided about wind energy.

Between 35% and 40% of all respondents did not give an opinion either way on both onshore and offshore wind. What was of considerable importance- and this has been emphasised before-- was that only 1 in 20 (5%) of the respondents had any experience of living near an onshore windfarm and a similar proportion regarding offshore windfarms.

There were considerable variations in the figures for and against throughout the various regions of Wales. This was put down to people's reactions to those wind farms which are up and running-- as in the case of the marine wind farm at North Hoyle-- or to the proposed wind farm at Scarweather Sands in South Wales. Looking at the mixed results and conclusions arrived at, it would seem that this type of survey should not be used (as is often the case) to give support to future proposals for both onshore and marine wind farms.

On the surface many people agreed with the need for *renewables per se*, but had doubts about the motivations of both the windfarm developers and the Government and the likely impact on the landscape. There was

also a tendency for some to distrust the planning system and that future decisions appertaining to large Welsh windfarms should remain with the National Assembly and not the Department of Trade and Industry, an organisation that does not have the interests of the Welsh at heart. Even this latter idea would have been tempered by the decision taken by the Natonal Assembly in July 2005 to ratify the contents of TAN 8 and concentrate future developments in seven specific areas throughout Wales. In the light of these recent developments, perhaps the most important and damning evidence outlined in the survey was the fact that ‘developers who apply for planning permission have a privileged right to appeal against the local authority when their application is refused. However, individuals and communities who object to the development in their area have no such right.’(Bibbings 2004) Even if complaints are reviewed by the Ombudsman and subsequently upheld, the original decision made by the DTI *cannot* be overturned.

When it is realised that the legitimate right to object to individual windfarm developments is gradually being eroded and that future judicial enquiries will either be suspended or seen as irrelevant, then this becomes a major obstacle to any future development. In continuing with this draconian planning system the UK and Welsh Assembly governments have distanced themselves from those systems administered in Denmark, Sweden and several other European countries,-- countries with successful wind energy industries. These countries have planning systems which incorporate a third party right of appeal, which has in many cases resulted in an overwhelming majority in favour of wind energy.

iv) 'Understanding Public Perceptions of Wind Energy.'

Three case studies of public attitudes towards wind farm developments.

1) In recognising that public acceptability often poses the most significant barrier to renewable energy development, the type of research conducted to ascertain public perception of wind energy becomes increasingly important. In a recent paper Devine-Wright (2004) reviewed existing research on public perception of wind energy and how ideas have moved on from earlier NIMBY concepts. Most recent research 'is characterized by opinion poll studies of general beliefs and case studies of perceptions of specific developments'(Devine-Wright 2004) which failed to adequately explain perceptual processes.

What is most evident from the outset is the fact that where renewable energy developments, such as wind farms, are concerned there is a 'juxtaposition of high and stable levels of general public support with frequent local opposition to actual development, a phenomenon that has become known as the NIMBYism (not in my back yard) attitude.'

(Devine- Wright 2004)

In attempting to explain some of the opposition to wind farms, the paper points out that the majority of empirical research studies have focused on the same key questions. These include the type of physical and environmental characteristics normally linked to negative perceptions, how living close to wind farms affect attitudes and do these negative attitudes lessen over time. Many of these thoughts are encompassed by NIMBYism -- an attitude of mind frequently decried by those agencies wishing to press forward with wind farm developments.

Researchers trying to identify possible reasons for public opposition to wind farms have noted visual impacts and noise as the most frequently reported problems. When taking these into consideration along with a number of others, it was concluded that smaller wind farms are more positively perceived in comparison with larger scale developments. There was a 'negative linear relationship between wind farm size and public support.' Again these findings were replicated in several other countries including Netherlands, Ireland and inevitably Denmark. Despite this, however, the current consensus in wind energy policy in the UK is towards developing large scale wind farms -- with both larger turbines and in larger numbers.

In doing so, it continues the policy of the large scale, centralized electricity supply infrastructures inherited from the exploitation of fossil fuel and nuclear energy supplies, rather than the people or community centred approach favoured by some other countries.

Numerous studies of visual perception have been undertaken but the general consensus of opinion is a preference for small numbers or clusters of turbines combined with a sensitivity towards positioning them on upland landscapes. An important feature of the research carried out by Devine--Wright was the acknowledgement that despite the growing controversy accompanying the visual and environmental impacts of onshore wind farms, there was only 'a limited degree of empirical research to date, on perceptions regarding offshore wind farms.' It is safe to assume, however, that if there are significant differences between 'objective' and 'subjective' landscape perceptions when considering

onshore wind farm developments, then this would apply equally well to any future large scale offshore developments.

This situation can have serious implications for the developers of the Gwynt y Mor offshore wind farm where it is expected that over 200 of the largest turbines will be sited off Llandudno, something which has already prompted considerable opposition. As previously mentioned the use of photomontages in illustrating the link between distance from a residential location to the nearest turbine and possible negative perceptions have proved to be inconclusive, despite numerous announcements to the contrary by those energy companies involved in developing new wind farms. (CPRW 1998) This was also the case when investigating the idea that the negative perception of wind farms lessens over time. As an example of how results can be interpreted to suit a particular point of view, Devine-Wright quoted the results of a study of public perceptions of three Welsh wind farms before and after construction, where approval seemingly improved from an average of 41% beforehand to 66% afterwards. This general increase, however, masked a large degree of variability across the three sites under consideration. In two of the sites studied, 'the proportion of respondents with negative perceptions of development actually increased.' (e.g. Llandin的角度 from 12.1% to 22.7% and in Rhyd-y-Groes from 29.8% to 35.1%.) This does indicate how results should not always be taken at face value. This situation was recently (Nov. 2004) duplicated in the successful application for a further 9 large turbines on the Moel Maelogan farm situated on the fringes of the Snowdonia National Park above Llanrwst. During an enquiry, several village councils

close to the site voted against the increase in the number of turbines from that which comprised the original small development of 3 turbines. They had approved the earlier development on the grounds that it represented a typical small community wind farm, well suited to this part of Wales and one which the local villages would benefit from financially.

The research undertaken by Devine-Wright concluded that resistance behaviours were 'directly explained by *local factors* rather than the more *general arguments* in favour of wind energy (e.g. that wind energy is a clean energy source).' Attitudes towards the development of local wind farms helped to explain the wide variance in resistance behaviour. There was, however, little hard evidence in research outcomes to indicate that the NIMBY concept could be used to describe negative perceptions of wind farms. Indeed those opposed to wind energy locally were not in favour of wind farms anywhere. If future large wind farm developments, both onshore and offshore, are to give rise to statutory enquiries into public perceptions and acceptability (and in the light of recent proposals this is a big 'if'), then future research will need to move away from opinion poll studies using an 'overemphasis upon a single type of research approach: the market research-orientated case study design using a quantitative survey tool' towards more 'theoretically informed empirical research, grounded in social science concepts and methods.' (Devine-Wright 2004)

He advocates the adoption of an interdisciplinary approach when trying to understand public perceptions. If, as expected, there is a move away from rural, upland wind farms towards the development of large scale offshore

wind farms then there should be a move towards a greater emphasis on the dynamics of the public perception of initial policy making.

‘Moving away from assumed public opposition to wind farms motivated by negative perceptions of specific physical attributes of turbines e.g. colour, size and orientation, towards more symbolic, affective and socially constructed aspects including ‘how’ wind farms are developed as much as ‘what’ is developed and how people come to make sense of the impact of an unfamiliar technology upon the places in which they live.’(Devine-Wright 2004)

He goes on to outline a number of initiatives which may need to be considered when future surveys are undertaken. In the first instance, he foresees a time when there will be a need for a new type of social research into the impact of the development of smaller-scale, building integrated wind turbines in urban areas, part of the drive towards eco-friendly environments.

Secondly, he advocates the use of new forms of photomontages, as a research tool to investigate cognitive perceptions of wind farm aesthetics. These would serve to illustrate the interaction between turbine colour and size, wind farm shape and size and how they fit into the landscape context. Work on these variables has been carried out in Denmark, including the use of colours designed to blend into the background and the siting of turbines in rows or clusters. (DWIA 1999)

With respect to communities directly affected by wind farm developments there is a need to discover how the public came to know about such proposals, their own perception of wind farms, whom they can trust to

guide them through each stage of the planning process, resulting discussions and inquiries and finally how the eventual outcome will affect them.

2) 'The wind energy debate represents a new kind of environmental controversy which divides environmentalists of different persuasions, who attach contrasting priorities to global and local concerns'(Warren et al 2005)

Research undertaken by the authors looked at the conclusions from case studies of public attitudes towards existing and proposed wind farm developments in Scotland and Ireland, in order to test three counter-intuitive hypotheses derived from previous attitudinal research.

These are that :-

- a) Local people become more favourable towards wind farms after construction.
- b) The nearer one lives towards the turbines the greater the acceptance.
- c) The NIMBY syndrome does not adequately explain variations in public attitudes.

Despite widespread support for greater use of renewable energy to mitigate the threat of climate change, the development of wind energy has proved to be controversial, with the opposition stemming largely from concerns about the transformation of natural landscapes into landscapes of power.

Whereas previous environmental debates usually revolved around the balance between economic benefits and environmental costs, with the 'green' element heavily biased towards the latter, in the case of wind

power there are strong 'green' arguments on both sides. Reviewing the recent growth and development of wind energy in the UK the paper (Warren et al 2005) points to the fact that Scotland and Ireland have between them some of the best wind resources in Europe.

However, despite the potential to supply a high proportion of these countries energy needs, at the time of the research only 11% of Scotland's electricity requirements was generated from renewable sources and only 2% in the case of Ireland.

These studies also revealed that earlier public attitude surveys found that 'communities seem to favour wind power as an abstract concept but oppose wind power in their own area'. (Warren et al 2005) There was support for wind power in theory but not in practice when it came to the real thing; something often referred to as the NIMBY syndrome. More recent surveys would suggest, however, that uncertainty has given way to a situation where the public has become more familiar with reality with NIMBY-ism in decline.

Whilst there are indications of a move away from NIMBY-ism and a move towards a more favourable view of wind power by the majority of the public, Warren counters this by pointing out surveys which highlight a number of important problems. These include 'the nature of the planning and development process-- something which should begin at an early stage, be more open and participatory, in contrast to decision making over the heads of local people which is the direct route to protest.' (Warren et al 2005)

This latter statement will have an even greater impact when decisions

regarding wind farms designed to produce more than 50MW of energy will ultimately be made by government departments, whether English, Welsh or Scottish, regardless of public opinion.

They also site the contested issue concerning intermittency of electricity supplies and the inability of government to decide on an overarching energy policy in general and the part played by wind energy.

Warren concludes that 'whereas more recent surveys of public attitudes to wind farm development show little or no evidence of the NIMBY syndrome, this has been replaced by a more realistic sense of opposition often founded on fact rather than theory.' (Warren et al 2005)

Results of the survey indicate a mixed picture. (as is often the case with similar surveys) It was found that opposition to windfarms arises in part from exaggerated perceptions of likely impact, and that the experience of living near a wind farm frequently dispels these fears but that elements of typical NIMBY attitudes still exist as shown in the desire for windfarms to be 'out of sight, out of mind' in uninhabited and offshore areas. Some results also support the view that aesthetic perceptions, both positive and negative are the strongest single influence on public attitudes. It follows then that 'unless or until there are accepted methodologies for assessing the sensitivity of different types of landscape to different sizes and numbers of wind turbines, an element of subjectivity will always exist.' (Warren et al 2005)

3) The complexities of public support for wind power are well illustrated in research carried out by Maarten Wolsink on the reasons for the stagnating implementation of wind energy policies in the Netherlands in

the late 1990s. (Wolsink 2000)

Wolsink makes the point that project developers are often faced with opposition to their project-- much to their surprise. It is generally supposed that support for wind power runs high in all major wind-power producing countries. Despite this many new developments encounter resistance, simply because energy companies take the general public support for granted and expect people to welcome every individual development regardless of size and position.

He goes on to say that 'If it is true that the public favours wind power but not wind power *projects*, why do we emphasise that public popularity of wind energy?' (Wolsink 200) Even more controversially, he questions if it really matters if wind power is popular and should it even be considered as a relevant factor in wind turbine siting in the first place?

Wolsink looked at the NIMBY syndrome when linked to a positive attitude to wind power but with a resistance against a particular project. The data collected for this research was based on interviews taken before and after building turbines on three major wind farms in the Netherlands. He concluded that NIMBYism was often misunderstood and that the common sense phrase 'wind power is perfectly fine, but not in my backyard' is a very poor explanation for the opposition against wind power developments.

Since the current use of the concept has important consequences for all parties in the siting process a much clearer view of NIMBYism is needed. The concept does not allow any distinction to be made among a broad range of attitudes. 'By labelling all protests as NIMBY one misses the

multitude of underlying motivations.’(Wolsink 2000) There are a number of forms of resistance, some of which are wrongly attributed to NIMBYism, which may exist towards the siting of any facility e.g. nuclear waste facility and power plant, but which can equally apply to wind power.

There is evidence that attitudes for or against may change during the planning process for a project. Much of this can be attributed to inadequate procedural opportunities for public consultation and participation in planning policy. The level of public acceptance in the Netherlands in late 1990s was similar to acceptance in Germany, where the growth in wind power was impressive. Despite this, implementation rates in the Netherlands were stagnating and the Dutch wind energy policy remains ineffective. Wolsink considers that the reasons for failure are of an ‘institutional’ nature. Despite public support the Dutch maintained a top-down policy, in which the all important factor of careful siting of wind farms is sidelined and viewed as ‘merely a market imperfection or a bureaucratic obstacle -- an attitude hardly conducive to effective planning’ (Wolsink 2000)

There are powerful contradictions between renewable energy and environmental values. Wind as a clean energy source requires turbine sites in environmentally valued locations. In many countries, wind power potential is geographically concentrated in ecologically sensitive areas. The problem was would it ever be possible to ‘square the circle’ and reach a situation which would satisfy everyone.

To illustrate this concept Wolsink points to a survey conducted in the

Waddensea wetland region in 1998, an ecologically important area of shallows, but one which is situated next to the location for half of the economically feasible wind energy potential in the Netherlands. As a result of the survey it was found that the strongest reason to oppose wind farm development was the degree to which wind turbines would spoil the landscape. In spite of this there was a strong agreement that even in an environmentally sensitive area like the Waddensea, suitable sites for turbines will exist. The question was which sites were the most acceptable? (There are certain parallels with the setting up of the 7 Strategic Search Areas in Wales)

The Wadden Union, a national environmental organisation founded to monitor all activities within the Waddensea with respect to ecological consequences, eventually accepted the establishment of wind farm facilities within industrial and harbour areas. At the same time it was reluctant to agree to what might be considered suitable locations within the area in question. In this way environmental organisations in the Netherlands, of which the Wadden Union is a typical example, continue to oppose certain sites designated by the government because of their top-down style in which wind power projects are planned first and third party acceptance is requested later. Hence, organisations remain reluctant, instead of co-operative, in selecting suitable and acceptable locations. Within the context of everyday Dutch physical planning practices 'stakeholders tend to assume conservative standpoints for legal-strategic reasons. Otherwise they would feel as if they were relinquishing precious bargaining power in the decision making process.' (Wolsink 2000)

Wolsink concludes that, the stagnating implementation of wind energy in the Netherlands and the reticent position of the Wadden Union despite the more favourable attitude of its members towards limited wind sites are both examples of the crucial impact of institutional arrangements. To this end, institutional constraints are often more important than public acceptance. The way to better implementation rates and improved development of wind power is to build up *institutional capital* by adopting a collaborative approach to planning. Quoting strong public support for a particular development is not sufficient but when used as an aspect of a collaborative approach it will contribute favourably to a siting policy. More open planning practises are needed and these 'can only emerge from reducing the arrogance of utilities, wind power developers and public bodies involved. (Wolsink 2000)

Research has, therefore, concluded that attitudes towards wind farm proposals are complex and conflicting views are to be expected. There are various ways, as we have seen, in which public acceptability may be enhanced, but these cannot be seen as a universal panacea. There will always be conflict between those groups who promote wind power as the right way towards sustainable energy on the one hand and those who are concerned with the protection of the natural landscape on the other.

It was also evident that earlier efforts to demonstrate public attitudes towards wind farms, including opinion polls and questionnaires, were inaccurate, inappropriate and rarely gave a true picture. In many cases this approach was used in order to justify the claims of energy companies towards individual developments but which only resulted in greater

opposition.

There is therefore a need to develop new more precise procedures, as for example the Q-Methodology way, in order to give us a 'clearer, harder, more sensitive and sophisticated awareness of public attitudes and a greater understanding of how these attitudes are formed.' (Walker 1995)

This need will assume greater importance as wind farm developments become larger and more widespread and with it a subsequent increase in public opposition to such plans.

SECTION 6

A PARTING OF THE WAYS ?

How the Welsh Assembly's long term plan for renewable energy conflicts with the BWEA's commercial expectations for wind energy

On the 13th July 2004 the Welsh Assembly Government, in the form of the Department for Environment, Planning and Countryside, issued notice of a new Interim Planning Policy Statement and Draft Technical Advice Note (TAN) 8. This notice was concerned with an up to date assessment of 'securing the right mix of energy provision for Wales, whilst minimising the impact on the environment. This would be achieved by strengthening renewable energy production, and through a greater focus on energy efficiency and conservation.' (Draft Technical Advice Note 8 Renewable Energy July 2004)

The purpose of the TAN was to show that the Welsh Assembly Government has set a target of 4TWh to be produced by renewable energy in order to meet the UK national target of producing 10% of its electrical power production by 2010. It considers current production and outlines future renewable energy targets and specific issues which arise from meeting these targets. It is primarily aimed at local planning authorities, but amongst other groups mentioned are environmental groups and members of the public. By specifically including these latter groups it is acknowledging the increasing awareness of opposition to certain forms of renewable energy, in particular wind energy.

Although the final version of the draft TAN is expected to remain in force until around 2010, when it will be re-examined to consider a further

target of 20%, it recognises the technologies associated with renewable energy are developing rapidly. Any developments on this scale, especially with regard to wind energy, will bring with it an increase in problems usually associated with planning and public opinion, many of which were unforeseen as little as 3 or 4 years ago.

The Assembly Government has decided that 'in order to meet its 4TWh target, 800MW of additional capacity will be required to be provided by large scale onshore wind by 2010. A further 200MW will be obtained from offshore wind power and other renewable technologies.' This is in addition to the already installed and approved capacity of 615MW as at May 2004.

The proposal makes the important conclusion that Wales has the resource and landscape capacity to deliver these targets. This will, however, rely heavily on local planning authorities and other stakeholders working to fulfil their obligations in order to meet this target.

It is at this point that the TAN sets out some of the major problems associated with these proposals :-

(i) The strategic assessment of the opportunities for wind power capacity in Wales is based on the premise that there are environmental, landscape, technical, national security and economic constraints that will determine the location of these wind power proposals.

(ii) The Assembly does not consider that the siting of large scale (25MW+) wind farms is 'appropriate in National Parks (NPs) and Areas of Natural Beauty (AONBs), recognising their designation as areas of value as a result of the landscape they protect.' (TAN 8 2004) They go on to

say, however, that *small scale domestic or community based turbines may be allowed under certain circumstances*. This latter statement is a highly contentious one, and as we shall see later, is open to a great deal of manipulation.

(iii) The assessment undertaken in relation to the 2010 renewable energy target also precludes major wind power developments from within Natura 2000 Habitat sites. These include the following:-

Special Protection Areas (SPAs)

Certain Special Areas of Conservation (SACs) and Ramsar Sites (RSs)

National Nature Reserves (NNRs)

World Heritage Sites (WHSSs)

The removal of the above sites from the overall map of Wales reduces the areas considered suitable for the development of large scale wind farms. This is further compounded by the removal of large areas currently under the jurisdiction of the Ministry of Defence and land within 500m of cities, towns and villages. The long list of constraints also included civil airports and military airfields, telecommunication masts, SSSIs, country parks and Heritage Coastlines, of which there are a large number. (Map 3)

In the search for suitable sites, wind power developers and consultants have long recognised the situation outlined above, but have frequently endeavoured to circumvent these problems, often blaming outdated planning restrictions and government interference. An example of this can be seen in the British Wind Energy Association's answer to TAN 8. The BWEA welcomed the opportunity to respond to the draft TAN 8 document and presented a detailed submission on behalf of the UK wind

energy industry. As they point out, they represent 345 companies, including 98.8% of all grid connected wind energy now installed and every company with a lease to develop offshore. As such they have consulted their members, with a particular focus on Wales and have discussed the issues and concerns arising. What is particularly interesting is the fact that they 'would like to make it clear that neither the BWEA nor its members were consulted in the production of TAN 8, and/or the designation of strategic areas from which to meet the onshore wind target.' (BWEA Representation: Draft TAN 8 Consultation, November 2004)

As a representative of the wind industry, it could be safely assumed that the Welsh Assembly would place the BWEA near the top of the list of technical advisers, in order that an amicable agreement on the way forward could be reached. A critical examination of their submission does, however, highlight the major differences in the way each group approaches and determines the provision of wind energy. Although the Welsh Assembly has recognised the need to meet the UK's national target for renewable energy, it has also recognised the need for greater energy efficiency and most importantly that they have a responsibility to look very carefully at the siting of each individual wind farm. They cannot be seen to allow indiscriminate developments in sensitive areas.

On the other hand the BWEA, whilst welcoming the inclusion of a 800MW onshore wind target for 2010, believe that the target cannot be met solely from the 7 strategic areas outlined in TAN8. They go on to say that 'the industry looks forward to working with the Assembly to identify

alternative and additional options to ensure targets are met.'

It is clear from their submission that they do not agree with the Assembly's criteria for identifying suitable areas for future large scale developments. At the same time they see smaller developments outside the Strategic Areas (< 20 Turbines or < 50 MW) as a possible way forward. In many cases, however, smaller developments would still come within areas subject to various constraints and recent history has shown that similar developments can be used to bring about a significant increase in both numbers and size, shortly after the original site has gone on line.

The BWEA agree that urgent attention is needed to meet 2010 and 2020 targets, especially when considering planning consents, grid capacity and connections. In their view planning consents for wind farms in Wales take too long to come to fruition. Furthermore they *strongly recommend* that in order to speed up the planning process it is essential that 'there is a need to provide additional resources and training for planning authorities.' In addition they believe that there is a reluctance by some LPAs to welcome the new national policy and that the Welsh Assembly should put pressure on them to ensure that they adhere to the objectives and policies. Whereas they (BWEA) accept the argument for not siting large scale wind farms in or near NPs and AONBs, they are less enthusiastic where SPAs and SACs are concerned. They argue that these areas are not always 'no go' areas for ordinary developments and that wind farms should be treated in the same way. They pursue the argument that there 'is a need for additional grey strategic areas which can be identified in TAN8 and are subject to individual proposals demonstrating that the special nature

of the designation will not be unacceptably compromised.’ (BWEA 2004)
Without these additional areas they maintain the onshore target will not be met.

The whole tenor of their argument is that the Assembly’s list of constraints is over restrictive. Many of the constraints levied on SSSIs, nature and bird reserves are site specific and depend on whether the renewable energy development would compromise the purpose of designation. These and many other comments are made *specifically to maximise the amount of land available* in Wales for large onshore developments.

On a number of occasions they reinforce their argument that they were not formally consulted in the production of TAN8 and that they consider that the *BWEA are best placed* to understand the viability or otherwise of wind farm sites. Even more dogmatic is their assertion that *all TTAs, SACs, SPAs and AONBs should be moved into the variable constraints category*--- in other words part or all of a major wind farm development, could if necessary, be *constructed within any of these areas*.

This impasse between the two concerns is then the major reason why planning can take up to 3 years for some developments. It is clear from the BWEA’s submission that their only concern is purely commercial, and to this end they use the pursuit of national targets for renewable energy as a means of forcing through their own plans.

The BWEA clearly do not understand or simply choose to ignore the fact, that the Welsh Assembly has reached the conclusion that there are only a few unconstrained areas in Wales that are capable of accommodating large

(25MW+) wind farm developments. It should be clearly understood that they have *both national and international obligations* to preserve the integrity of National Parks, AONB's and other Natura 2000 Habitat Directive sites.

This view has recently (January 2005) been reinforced with the announcement by the Welsh Minister for the Environment, that a further 90 sites have been designated as Special Areas of Conservation (SACs) under the Habitats Directive. One of the most important effects of SAC designation is that 'developments must undergo rigorous assessment. Damaging projects can only proceed if they are of over-riding public interest. SACs, therefore, help to strike the right balance between conserving Wales' fine natural heritage while not standing in the way of sustainable development' (NAW 2005)

Along with the problems associated with the actual wind farms, it should also be noted that the existing electricity distribution network will be required to absorb a percentage of any new output. Constraints will be put on any new overhead distribution lines in order to minimise potential adverse impacts on the landscape.

When the information from the environmental and technical constraints mapping are examined, it becomes clear that only a few unconstrained areas in Wales are capable of accommodating large wind developments. It is assumed by the BWEA that approx. 1200MW would be developed in these unconstrained areas. This is well above the estimated 800MW required by 2010 and would even go some way to reaching the new 2020 target.

The one major objection to this situation is that there will be a cumulative build up of large wind farms in a small number of areas, reinforcing the long held view of protesters that 'the Welsh landscape will be industrialised.'

This is the situation which will need to be addressed in North Central Wales. At present there are just six onshore wind turbines operating in this area, including three at Moel Maelogan, a privately owned site previously discussed. (with plans for a further 9 turbines already passed.) There are, however, plans in the pipeline for the construction of up to 100 large modern turbines, each over 100m high. Consent has been given for 25 turbines at Tir Mostyn/ Foel Goch in Nantglyn, a site close by a National Nature Reserve and planning applications are in the pipeline for a further 28 turbines on six sites. Discussions are currently taking place with landowners (encouraged by lucrative contracts as an alternative to farming) at a further five locations throughout the area.

An example of the mixed messages being put forward by the Assembly is evident in the five small wind farm developments mentioned above, which have been submitted to three neighbouring county councils, Gwynedd, Conwy and Denbighshire. They comprise:-

A further 3 turbines at Hafotty Ucha, Llangwm.

8 turbines at Cwmpenanner, Corwen.

5 turbines at Mynydd Rhyd Ddu, Corwen.

3 turbines at Braich Ddu, Corwen.

The three county councils are all concerned about the cumulative impact of each scheme in relation to each other, and to the landscape in general in

this area. They consider that since almost all the turbines will be visible from the main A5 route into N. Wales, this will have a detrimental effect on tourism. In this example an analogy may be made with the example set by the hundreds of turbines erected in the early 1980s along the Altamont Pass, California.

Following a year long comprehensive consultation exercise, the revised Technical Advice Note 8 -- Renewable Energy was released by the Welsh Assembly Government on the 12th July 2005. The new document identified areas in Wales which, 'on the basis of substantial empirical research,' are considered to be the most appropriate locations for large scale wind development. These areas are to be referred to as the 7 Strategic Search Areas (SSAs) and the detailed characteristics and the methodology used to define SSAs are outlined in TAN 8. (Map 4)

Several sections of the original Planning Policy Wales (PPW 2002) were amended in the new version of TAN 8, which could have a major impact on planning decisions made by local authorities. An important item often played down in planning considerations was the inclusion of additional electricity grid network infrastructure which will be needed to support new developments in the proposed SSAs.

Any decision to designate just seven areas in Wales where wind farms can be constructed, whatever their size, will have the effect of concentrating large numbers of turbines in any one area and with it a tendency to exaggerate all those elements which opponents normally put forward i.e. visual impact, noise, environmental damage etc. This situation will make the task of reaching the appropriate planning decision much more difficult.

Thus we have a situation where on the one hand, local authorities are exhorted to take into consideration 'where a development is likely to cause demonstrable harm to a designated area by virtue of having a significant adverse impact on the qualities for which the site was designated, consideration should be given to refusing the development if such efforts cannot be overcome by mitigation methods, planning conditions or obligations.' (Ministerial Interim Planning Policy Statement 01/2005 -- Planning for Renewable Energy --- Amendments to sections 12.8 to 12.10 of PPW 2002). At the same time local planning authorities, particularly those containing SSAs, are required 'to take the national imperative for renewable energy into account whenever they are consulted on applications for large scale onshore wind power projects'.

In the outline of the best way to reach national targets the Welsh Assembly give scant attention to the future of offshore wind farms. In a brief paragraph the draft TAN concludes that offshore wind farms may be more efficient generators of electricity than onshore installations. However, despite all the difficulties with planning and constraints associated with onshore wind, they decided that offshore developments, which have many positive attributes, *did not come within the remit of TAN 8*. Electricity they generate, however, will count towards meeting the overall target for renewable energy and a modest target of 200MW has been set for offshore wind power. This insistence on promoting onshore wind energy, complete with all its problems, is something which protesting groups are quick to seize on. In opposition to these proposals, objectors have shown that along the N.Wales coast alone, proposed and existing offshore wind

turbines will have an installed capacity of 910MW and will operate at a 40% annual load factor

North Hoyle 60 MW -- existing

Rhyl Flats 100 MW -- consent given

Gwynt y Mor 750MW-- planning application in progress

To put this into context, the Mynydd Rhyd Ddu onshore application for 5 turbines will produce just 1.95MW rated capacity and operate at less than 30% annual load factor. Rounds 1&2 offshore wind energy developments situated round the UK coastline are expected to produce 8.4GW - 48 times more than the capacity of all the currently installed onshore wind turbines throughout the UK.

The consequences of the Assembly Government committing itself to achieving specific targets for renewable energy production, are that local planning authorities and county councils are being placed in a dilemma of considerable proportions. Whilst details are worked out by the appropriate planning officials, the final decision regarding a particular development will often be left to a committee of local or county councillors, many of whom have little or no practical knowledge of the subject. Where decisions go against those agencies submitting plans for developments i.e. BWEA, the inevitable appeal by a particular agency and final decision by the Welsh Assembly all add to the cost and increased frustration felt by all parties. This situation may well become increasingly fraught if or when the Government seek to overrule the Welsh Assembly on decisions appertaining to wind farm developments over 50MW.

SECTION 7

CONCLUSIONS AND RECOMMENDATIONS

i) An Overall Summary

Human advances during the latter half of the 20th and early 21st centuries are closely bound up with an unprecedented rise of total energy consumption. During this time oil and gas has relegated coal as the dominant energy base, with the exception of those countries with large indigenous reserves of coal, as for example, China, Poland and Russia.

The development of modern societies which could not exist without a large and incessant flow of cheap energy, has resulted in a number of major environmental problems. Throughout the century the extraction, transportation and conversion of fossil fuels, and the generation and transmission of electricity from these fuels, has resulted in both local and regional environmental impacts. These have included the destruction of terrestrial ecosystems, water pollution, acid rain and petrochemical smog. Individual solutions to many of these problems have been found with positive and lasting results. However, over several decades a new and potentially extremely damaging threat has been identified. The rising emissions of carbon dioxide from the combustion of fossil fuels has resulted in rapid global warming. Consequently, the future use of energy may not be determined '*just by the availability of resources or by the techniques used to extract and convert them and by prices charged for them -- but also by the need to ensure that the global energy consumption will not change many other key biospheric parameters beyond the limits compatible with the long term maintenance of global civilisation.*' (Smil 2003)

ii) Challenges

We are, therefore, faced with a twofold challenge in the foreseeable future. The first is to establish long range forecasts for energy needs and the shares of various primary energies which will supply that demand. The second is to ensure that whatever energy sources are used, there will be a significant reduction in the amount of greenhouse gas emissions including carbon dioxide.

New and renewable energy sources -- which produce either no carbon dioxide or far less than existing fossil fuel technologies -- will have to be substituted for coal, gas and oil, whilst at the same time maintaining the demand for ever increasing amounts of energy. This is especially so in relation to newly emerging economies, including India and China; the latter supporting an official population of 1.3 billion people. Before either of these challenges can be met, it is essential to look at two controlling factors which are part of the aims and objectives of any future energy forecasts -- the long term growth in the world's population and how energy consumption may be maintained at sustainable levels by means of radical energy efficiency conservation.

iii) Population & Economic Growth.

It is estimated that growth rates of global population that have prevailed during the 20th century, will not be replicated during the 21st century. In 2000 the global population was estimated at 6.1 billion, but despite the fact that the relative rate of growth is declining, it is estimated that the world's population will reach 9 billion by the year 2050 . Even if this figure is considered to be an overestimate, even a small population total increase will further exacerbate the problems associated with global

warming seen today.

Those countries associated with the highest population growth rates, e.g. China, India, Brazil are also those showing above average economic growth rates-- in part sustained by a rapid increase in internal living standards. Many of these countries will continue to use indigenous fuel sources e.g. coal and oil, to provide energy for manufacturing purposes, and in so doing add to the emissions problems. Although fossil fuels, especially oil and gas will represent a slowly declining source of energy, the cumulative effect of greenhouse gas emissions from the generation of these fuels will still result in a continuance of global warming. If population figures are continuing to rise, albeit at a slower rate, and with it a parallel increase in energy demands, then a greater emphasis must be placed on finding ways of using this energy more efficiently. In the UK alone there is ample opportunity for further large efficiency improvements in the use of energy by manufacturing industry, commercial and public services, households and transport. Improvements can be made in buildings of all kinds and especially in housing.

iv) Energy efficiency.

Figures published by the Office of National Statistics, show that 34% of the total electricity consumption in the UK for 2002 (ONS 2004), was accounted for by the domestic sector -- an area where a considerable saving could be made.

Many of the technical innovations to produce higher efficiencies have been with us for some time, but have often been introduced as a means of improving the product, with energy saving as an added bonus. This effect can be seen in modern designs for electrical appliances and cars.

Over the last three decades-- ever since it was realised that massive energy savings were necessary-- many reviews and appraisals of higher energy conversion efficiencies have promised much but have always erred on the high side. A more detailed review of the potential impact of a small number of energy saving techniques is required -- those techniques which can be quickly and easily realised. Inefficient electric motors, lighting and appliances are suitable candidates for replacement and the subsequent energy saving is the easiest and quickest to achieve. Considerable electricity saving can be achieved by the replacement of incandescent light bulbs and standard fluorescent tubes with the most energy efficient bulbs, both at domestic and public lighting level.

The advent of remote--ready televisions, video recorders, audio equipment and computers has resulted in a rising demand for electrical energy. Of the total electricity demand for these devices, almost 20% of the use is due to standby losses. New designs for domestic appliances where standby losses are greatly reduced would represent a small but cumulatively large energy saving. Although not directly connected to electricity generation and improvements in the efficiency of electrical systems, improving the performance of private cars and public transport would result in a major reduction in gas emissions. Transport in general is estimated to use 1/6 of the Total Primary Energy Supply. Although most car manufacturers have produced more fuel efficient models, the tendency towards larger cars and a reluctance to switch to public transport has resulted in little, or no, energy saving. Failure to reduce gas emissions places an extra burden on renewable energy sources to meet overall targets for reducing the amount

of carbon dioxide and other harmful gases in the atmosphere.

There is, therefore, no doubt that it is possible to develop devices and machines which convert fuels and generate electricity with higher efficiency levels, which at the same time lead to lower energy use and to a saving of money for individual consumers, households and companies. This then would seem to satisfy one of the long term aims of future energy forecasts.

There is, however, an important corollary to this outcome that '*increased energy efficiency can often lead to an increase in total energy consumption*,'(Herring.1998) which would seem to negate the original objective. Although cars in America have become more fuel efficient, they have become more powerful and the average distance driven has increased. Similarly whilst new houses may include a number of energy saving devices, the size of individual houses has grown, especially when compared with similar properties from 30 to 40 years ago.

The Danish experience shows that conservation policies can be made to work in spite of their unpopularity when first enacted. If the UK is going to reach any sort of target set for a reduction in energy use, then conservation in all its forms should be of primary importance. In Denmark measures are already in place that reward conservation, mostly through reduced private expenditure. The less energy that people used, the less they were vulnerable to energy price inflation, as is the case since 2005 when global prices for oil and gas to the consumer have risen. 'Conservation measures, properly implemented, will remove the need for financing and constructing new power generating capacity, and save the

purchase of and dependence upon greenhouse gas emitting fossil fuels.’ (Sharman 2002) It should be realised, however, that the task of implementing similar conservation measures in the UK, a country with a much larger population, will be considerably more difficult without government intervention, which they seem reluctant to do for fear of affecting the economy or upsetting the public.

v) Energy Sources

If energy consumption continues to rise, despite greater efforts to reduce the rise with greater efficiency, then new long term sources for energy supply are needed. Several new sources of energy have emerged as potential alternatives to fossil fuels. Exploiting these will give rise to a wide range of impacts on the environment. Such impacts ought to be taken into account from the outset in deciding what role each alternative energy source can play.

Any plans for future energy supplies and demand in the UK will be made on the assumption that under the Kyoto Protocol the UK has a target to reduce greenhouse gas emissions (GHE) by 12.5% on a 1990 baseline by 2008-2012, rising to approx. 30% by 2020, a target it is hoped will be reached, if not exceeded. The Kyoto target is based on a basket of greenhouse gases of which carbon dioxide represents the largest share.

Targets of the magnitude outlined above would assume considerable reductions in energy demands, something which we have shown will be difficult to attain. Carbon emissions from power generation are also expected to rise after 2010 because of the planned rundown of current nuclear power stations and a *possible* increase in gas powered stations. If, however, fossil fuels, including gas, are to be phased out *or* if supplies

from overseas are disrupted, then energy demands can only be met by a massive and environmentally intrusive contribution from renewable sources and a completely new set of nuclear power stations. Renewable energy, other than wind power, would also involve various mixes and levels of energy sources some of which are only in the early stages of development.

Despite many previous attempts to address the issue of reducing greenhouse gas emissions in the UK, achieving a significant reduction in the future 'may prove to be costly, raising wholesale prices of energy by perhaps 40 to 60% over a five year period'.(Simpson 2004)

It can be assumed, therefore, that the major contribution from renewable sources over the next two decades will have to be in the form of wind energy. The need for both onshore and offshore wind farms will dramatically increase. Whilst onshore wind farms would seem to be the best option from both a practical and economic point of view, they will continue to meet serious and understandable opposition. It can also be assumed that they would not be permitted in areas designated for natural beauty or importance to wild life. This would mean a greater concentration on the remaining areas with the highest wind speeds, predominantly near coasts or on higher ground and visible from almost everywhere in these areas.

To what extent the UK wind industry is expected to expand can be seen in predictions for wind energy targets for 2010 outlined in a recent BWEA press release. The Association expects to reach a total of 7,500 MW by 2010, developed half onshore and half offshore, which represents

7.5% of the UK's electricity needs or 3/4 of the governments renewable energy target. In order to meet such a target it would 'require the installation of an additional 2000 turbines onshore and a further 1500 offshore' something which is bound to meet with a good deal of opposition. (British Wind Energy Association Press Release 25th January 2005) This target would appear to be based on using turbines rated at 2MW, the average size being installed in 2000. The proposed 200 turbine Gwynt y Mor offshore wind farm would, however, use turbines with an individual output of between 3 and 4MW, which would considerably reduce the number of turbines needed to reach the 7,500 MW target.

At the present time the cost of generating electricity from wind power is higher than that of the cheapest conventional alternative source. However, if in the future there is the expected increase in the demand for oil and gas and a subsequent price rise, then wind energy will become far more economic even without any subsidies.

The principal instrument of government policy for promoting wind power is the Renewable Obligation scheme. The cost of the scheme falls onto electricity companies who pass it on to consumers in the form of higher electricity bills and these costs will remain until wind power reaches parity with more conventional energy sources.

It is, however, forecast that the generation costs of wind power per unit of output will fall over the next ten years due in the main to the economics of scale and specialization in the supply of wind turbines. In the short term a better understanding of onshore site selection will result in an increase in mean annual wind speed rates leading to increased energy output. By

2020, however, any increase in productivity may begin to fall away due to the effect of using inferior locations for wind farms. This will place a greater emphasis on offshore wind farms in the future, a situation which will be addressed by the construction of a number of large wind farm sites outlined in the government's Round Two programme for wind energy.

Nevertheless, studies have shown that the cost of wind energy should begin to fall. In a report for government the PIU estimated that by 2020 the cost of wind energy generated from onshore winds would fall to around £15-25 MWh from £37MWh in 2004 and for offshore wind to £20-30MWh from approx. £55Wh. (PIU 2002)

At the same time, these figures only account for generating costs only and any overall cost must include significant infrastructure investment, cost of transmission from the most productive areas in Scotland and Wales to markets in the South and additional balancing costs incurred with the use of conventional power generators. If then we include the additional costs outlined above future projections show that 'even by the year 2020 a generation portfolio containing 20% wind power would still cost more than a conventionally fuelled alternative.' (Simpson 2004)

vi) Comparisons with the Danish Wind Industry-- often seen as the best example for the future of the UK wind industry.

A review of the Danish Wind Industry by Soren Krohn published in 2002, envisaged a 50% wind penetration in the electricity grid by 2030. (Krohn 2002) In order to achieve this figure there would have to be a move away from the more traditional onshore sites to major new offshore sites. Shortage of land sites in Denmark -- a situation similar to that found in

Wales since the introduction of the 7 Strategic Search Areas -- and significantly higher wind speeds than on land, resulting in higher energy production, are put forward as reasons for the move offshore.

In 2001 the total generating capacity in Denmark was approx. 13,000 MW, of which 2,500 MW or some 18% was obtained from wind energy. With the construction of a large number of offshore wind farms yielding a total of 4000MW, it is anticipated that by 2030, wind energy will account for 50% of the total electricity consumption.

A major caveat to this optimistic forecast is that in this 30 year period energy consumption will not have risen much above the current annual electricity budget of around 33TWh. What is equally as important is the fact that Denmark is linked to both Sweden and Norway, which plays an important role in balancing the electricity supply in Scandinavia. Norway has a large, 90% hydro--based system, with an annual production of some 120TWh output, considerably more than is needed for Norway's small population. Denmark is, therefore, able to import large amounts of electricity from Norway via undersea cables in order to make up the shortfall in energy demands not covered by wind farms, or whenever the conditions are not right for maximum wind energy production. Theoretically Denmark would reciprocate the arrangement by supplying electricity to other countries in times of drought--- something which would be unlikely in both Norway and Sweden.

In a report written for Incoteco (Denmark) ApS (Sharman 2002) the situation in the UK was compared with that seen at the time in Denmark. West Denmark has a highly developed renewable energy sector which

includes the world's largest offshore wind farm at Horns Rev. In 2002, at the time of this report, it was expected to achieve a 'wind output' equivalent to 21% of its local consumption by 2003. This is the target the UK government aspires to by 2020. Its proximity and shared latitude with the majority of the UK and the large contribution that its wind turbine manufacturers (Vesta) will make to the UK's wind energy portfolio, make its experience with wind energy wholly relevant to the UK.

The average annual capacity factor (CF) for the wind carpet in West Denmark in 2003 was 20%, however, for the UK to achieve the target of 20% from wind energy by 2020, the average annual CF would have to rise to around 30%--- something which is difficult to achieve at the present time.

Despite such a large wind carpet, West Denmark can only avoid total system breakdown by relying on the size and strength of its interconnection with its neighbours Sweden, Norway and Germany. Because of its isolated 'island' situation the UK may not be able to cope with the intermittent nature of wind. A small fraction of total load and demand is provided by a 2000MW (2GW) interconnector to France--- ironically produced as a result of France's reliance on its 80% nuclear energy output.

Comparisons can be made between the two countries as to what effect the growth of the wind energy industry may have on the landscape. To supply West Denmark with 21% of its total energy consumption requires approx. 4,700 wind generators. There are about 2.7 mill. residents in West Denmark, so the number of wind generators per head of population is 1.7

machines per 1000 people. Extrapolated to the UK this would amount to about 100,000. West Denmark is therefore 'the most intensely wind mill populated land on the planet. These cover the landscape so that there are rarely parts of West Denmark, a flat, at the most gently rolling countryside, when they are out of sight.' (Sharman 2002)

The advent of larger and technically more advanced turbines (3.5 MW to 4MW) than those used in Denmark along with the larger wind farms being located offshore would reduce the impact on land, whilst going some way to achieving the UK target.

The overall situation at the present time regarding offshore wind farms both in the UK and in Europe is confused and somewhat difficult to understand. In a report to Greenpeace, the Deutsche WindGuard GmbH have outlined how it would be possible to supply 10% of Europe's electricity sector by 2020 and in doing so Europe will integrate 70,000 MW (70GW) offshore wind capacity into the existing electricity grid. These forecasts have, to some extent, been forced on the Germans because they were running out of space and 'as windfarms creep ever closer to towns and cities, the previously supportive public is turning against them.' (NATTA 2005) Although the majority of the German people are in favour of renewables, they do not want them close to where they are living and the government has warned that offshore wind turbines may be the only way forward. Because there are a number of nature protected areas along the shoreline any new turbines would have to be built in deeper water, a situation which would involve technical problems not previously encountered.

In direct contrast to future energy solutions as outlined by the Germans, the situation in the UK -- a country with a certain amount of experience with offshore wind farms-- is confusing. Research for the wind energy industry shows that only half of the expected number of offshore wind farms will be built by 2010.

When the energy companies were first allocated offshore sites, it was expected that there would be a steady fall in building costs once the manufacturing and engineering base had been established. This situation has not materialised and the difficulties have been compounded by a shortage of turbines and vessels to install them. Evidence of this can be seen at Npower's Rhyl Flats (which already has planning permission) and Gwynt y Mor which are already up to 3 years late. Extra investment is needed if government targets for 2015 are to be reached which may in turn remove some of the pressure of increasingly contentious onshore wind proposals.

As previously outlined the annual Capacity Factor (CF) is used to calculate how much installed wind capacity will actually be delivered. The figure obtained in West Denmark (app. 20%) is based on a significant number of carefully monitored machines. By contrast the statistics gathered from the UK wind farms is from a statistically less significant number of machines (mainly because there are far less machines in operation) and for a much shorter period of time. The actual CF achieved from existing machines will determine how much future capacity must be built in order to achieve the UK's target for renewable energy contribution. Any deviation under the average CF of 25-30%, often

assumed in the UK, will increase the risk that estimates for power generation from wind energy will be wrong.

Any figure above 30%-- the Dale study uses a CF of 35% (Dale et al 2003)-- is said to be justified by the argument that in future larger wind turbines and access to windier sites in Scotland and offshore England will improve performance. Against this it may be 'observed that, for a variety of reasons, only about 10% of the areas in Scotland with the best wind resources could be planted with wind farms.'(Simpson 2004) In England, the areas in the South East chosen for the next round of large offshore wind farms are, when compared with the Western coasts, notably less windy.

In spite of the limitations outlined above there is still a strong case for all future large scale wind farms in the UK to be built offshore. In Denmark it is expected that offshore wind farms will produce 50% more power than the equivalent onshore installations i.e. have a Capacity Factor of over 30%. On the assumption that the wind that blows over Denmark will blow over the UK in a similar manner and that the daily demand patterns are very similar, then the load-time curves produced in Denmark can be used to predict energy demands in the UK.

There will, however, be many days throughout the year when wind will supply less than 10% of the energy demand. Cold weather, which is often associated with high pressure systems over the winter, occurs on a regular basis throughout the UK and these systems can be large and persistent. Paradoxically, if it blows too much during low pressure systems, no power can be generated and both these occasions may coincide with periods

when heating and lighting loads can be at their maximum.

After examining future long term targets for wind energy and putting a figure to a possible capacity factor which may be achieved, an important characteristic of any wind resource is the one regarding its actual 'variability'. Sinden (2005) maintains that the 'pattern of electrical output of wind power is more accurately described as being variable, as it is the variation in output from one hour to the next that poses challenges for its integration into the electrical network'. He concludes that 'intermittent' generation is a misleading term.

A study conducted by the Carbon Trust (2004) reiterated the fact that all renewable energy sources , and this includes wind energy, are *intrinsically intermittent and are therefore unable to sustain a steady and consistent output*. It also emphasised that as the 'percentages of intermittent generation capacity increase and bcome more significant, additional uncertainty is created in the management of the electrical system on a real time basis to balance demand and generation.' (Carbon Trust 2004)

Consequently this will require increasingly large and costly amounts of conventional reserve capacity that can be made available immediately. (spinning reserve) On this issue the study found that whilst there were no major technical barriers to the implementation of dispersed intermittent generating systems connected to the networks and that costs up to 2010 will be small, however beyond this tme and certainly by 2020 these costs will have increased significantly. The cost of the increase in the amount of reserve the system needs to carry will depend largely on the type of spinning reserve plant which will be available at the time -- gas, coal,

hydro and nuclear. It concluded that it was sometimes difficult to transplant intermittency costs from other systems e.g. US, Denmark, Germany, and that these costs are not yet fully understood and that there are a number of areas where further research may enable costs to be reduced.

Using records of wind data covering the whole of mainland UK, a number of studies have been made into the relationship between hourly data of electricity demand and the variability of wind generation covering a period of ten years. One study by OXERA (2003) concluded that there are significant periods in a average year when demand for electricity is high and wind output is low. In one example there were '1642 hours when wind output was less than 10% of the maximum, including 450 hours when demand was between 70 and 100% of peak demand.'

This is in direct contrast to Sinden (2005), who, as a result of his research into Met. Office wind speed data for the period 1970-2003, concluded that 'very low wind speed events have a limited impact on the UK, and that very high wind speed events are extremely rare; no hours were identified where electricity production from wind power throughout the UK was curtailed due to these extreme events.' He did, however, emphasise 'the need to accurately incorporate wind power characteristics associated with different demand levels into wind power and electricity system modelling.' Some of Sinden's findings were examined in Section 4 (part i), and it was clearly shown that on certain occasions, low wind speed events *can* have a major impact on the UK power output. If wind speeds fall much below the speed needed (14m/sec) to maintain the maximum output for a turbine

over a period of time, then the resulting drop in output will have a serious effect. Several examples where this situation has occurred have been examined by the present author and it is not true to say that only 'very low' wind speeds will have a limited impact. Although 'very high' winds do occur less frequently wind speeds over 25 m/sec will result in the turbine being shut down and a complete loss of output.

It was also demonstrated that the power output from individual wind farm sites needs to be related to wind speed data collected from those monitoring stations which are geographically nearby, not from an average for the UK which can include exposed monitoring sites.

It has regularly been suggested that given a large wind power system spread over the length and breadth of the country and because of its location close to the source of some of the highest wind speeds in Europe, the UK will have the highest Capacity Credit.

Estimating future long term annual Capacity Factors (also referred to as Load Factor) in order to determine the proportion of wind energy in the overall power output, can be a complex subject as an examination of UK wind farm performances for 2005 and 2006 will show. (Oswald et al 2006) A map of the UK showing a comparison of mean annual Capacity Factors region by region, shows some considerable variations (Map 5), which may be summarised as follows :-

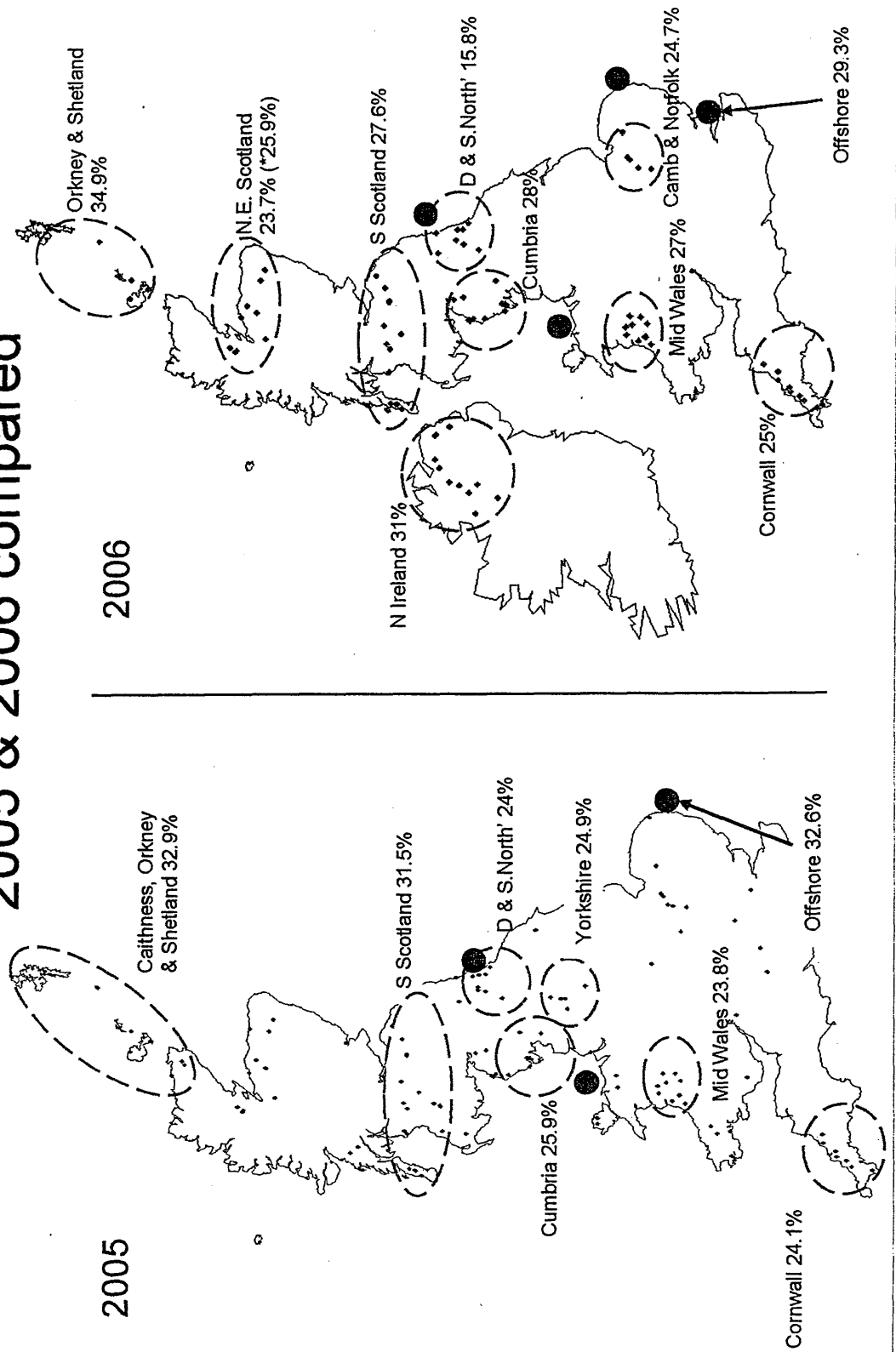
a) Annual figures for the whole region may vary from one year to the next. The mean annual Capacity Factor figures for England and Wales show a slight increase from 2005 to 2006 -- with one exception that of the D&S North. This may be due to the introduction of new more productive

wind farms or more favourable wind conditions throughout the year. However, whilst this shows progress, the average C F figure for the whole of England and Wales during 2006 (excluding offshore wind farms) was only 24%.

b) If you exclude the Orkney and Shetland Islands, where the construction of onshore wind farms is limited, the concept that Scotland because of its geographical position will be the key to 'smoothing' (a diversified wind system) is open to question. Whilst it is assumed that mean annual C F figures for England and Wales will in general be lower, the figures for N.E. and South Scotland for 2006 clearly show that these areas cannot always be relied upon to bring the overall figure up to the required amount. Capacity Factors for both areas were below 30% with N.E. Scotland only averaging approx. 24%, a figure well below the 40% expected in the future.

c) Figures for the four main offshore wind farms currently operating, give an indication as to where the future of wind energy as a viable form of alternative energy lie. With the construction of several large offshore wind farms envisaged in the Round Two, Capacity Factors will increase year on year. Despite the current offshore sites being adjacent to the English coastline they already have a higher C F than the average figure for mainland Scotland.

2005 & 2006 compared



MAP 5 MEAN ANNUAL CAPACITY FACTORS FOR UK
WIND FARMS IN EACH REGION 2005 AND 2006
 (OSWALD et al 2006)

The *actual* experience in West Denmark is outlined in a paper for Incoteco (Denmark), where the author argues that 'the wind that blows over Denmark will blow over the UK in a similar manner. It is valid to predict how a similarly large wind capacity will behave within the UK's 'island' grid system. The effect should be, more or less exactly proportionate.' (Sharman 2002) He goes on to suggest that 'it is imprudent, even naive, to place any hope in the likelihood that the UK, because of its larger size and more westerly geography, can expect firm demand, even with a larger wind capacity.' (Sharman 2002)

In West Denmark, there were 54 days in 2002 when wind supplied less than 1% of demand despite accounting for over 20% of capacity. Only twice during 2002 did local wind power exceed local demand and that for a few hours only. In a similar winter period to that examined by the present author in the UK (Jan/Feb 2006), February 2003 in West Denmark was cold but relatively windless and during this period virtually no wind power was generated. (Sharman 2002)

However, during the middle of 2003, output exceeded demand six times due mainly to an increase in capacity, which may indicate that if and when long term targets for wind power capacity are met then this form of renewable energy will make a significant impact on electricity demands. In any event because of the vagaries of the weather, wind surges, which in Denmark are accommodated by exporting and importing power to and from the much larger, neighbouring grids, will have to be accommodated in the UK by racking up existing thermal plants in order to maintain grid

balance and stability. National Grid have said that such events can be dealt with, even when wind energy is as low as 10%.

As the target for renewables, including wind energy, increases from 10% up to the UK national target of 20% by 2020, there may well be a need for a larger back-up capacity in the event of sudden surges. This situation is not helped by an existing situation where even conventional systems need to be backed up on occasions. All conventional energy systems, nuclear, coal, gas etc. fail occasionally and will need back up. The system is, however, designed to cope with regular “trips” of large power stations within minutes. A number of nuclear power stations have been taken out of service and in those that remain, breakdowns have occurred on a regular basis, resulting in a shut down for periods of weeks or even months.

In order, therefore, to accommodate any increase in demand resulting from adverse weather conditions, along with a major reduction of output from wind farms, it will be necessary to increase output from existing thermal or hydro and pumped storage plants. If the situation outlined above takes place, then the burden will fall on the gas and remaining coal fuelled generators, including the large Drax power station and the 360MW station near Newport in South Wales; hence the renewed interest in the ownership of these stations.

An ideal situation is, therefore, not possible in the UK and the expected contribution to the energy programme from renewable sources would always have to be augmented either by nuclear power, hydro power or by new fossil fuel power stations equipped with the means to capture and

isolate carbon dioxide. They would be needed to make up for the shortfalls of electricity from intermittent renewable energy sources such as wind, solar and at some later stage waves and tide. It should also be recognised that electricity generated by any source cannot be stored in very large quantities in order to even out the peaks and troughs of energy demands. Hence the need for massive and little-used reserve generation capacity.

One way of lessening the effect of sudden demand surges could be a revised system of 'off-peak' electricity tariffs. Electricity for heating and certain other purposes is supplied at cheaper rates at night and the heat stored ready for use the next day. This way a proportion of the daily energy demand has already been accounted for and any sudden increase in demand can be more easily dealt with, with less recourse to reserve generation capacity.

This system was used in the past at a domestic level but the method by which the heat was stored was big and clumsy and has since been superseded by modern heating systems using gas, oil or electricity. If off-peak electricity can be stored efficiently and cleanly and if other electrical loads can be safely turned off, then the process of 'load shedding' can make a significant impact. Because renewable energy installations are relatively small, there will be a need for more of them and they are likely to be widely dispersed. As a result the national grid and regional distribution system, currently based on a small number of major power plants, will have to be reorganised at considerable cost.

vii) The future of wind energy in N. Wales

An examination of proposals for future wind farms in N.Wales can be seen as a microcosm of the problems confronting the wind industry in Wales in general and to a lesser extent throughout the UK. The Welsh Assembly Government has shown through a number of earlier reports and its latest TAN 8 proposals that it is strongly supportive of renewable energy technologies. The Assembly intends to deliver an appropriate energy programme and secure the right mix of energy provision in Wales. This is to be achieved by increasing renewable energy production, and by a greater focus on energy efficiency and conservation. They have concluded that wind power is at the present time the only clear and realistic technology capable of delivering sufficient renewable energy to meet its 2010 target. To this end it suggests that a few large scale 25MW wind farms situated in a limited number of areas offers the best opportunity to meet the requirements.

At the regional level the outlook is not as clear cut and criticisms have been levelled at the lack of clarity in the Assembly's proposals. Seven strategic areas have been identified as being most suitable for large scale wind farms, the Denbigh Moors being one such area, with a potential to accommodate at least 200MW of capacity. It is estimated that in terms of this particular site, 200MW equates to 50-70 turbines depending on the size of each turbine. Both Conwy and Denbighshire County Councils have voiced strong concerns about a lack of consultation with the Assembly Government over the suitability of the Denbigh Moors as one of the strategic areas.

Their concerns include :-

- i) The unsubstantiated nature of energy targets set for Wales.
- ii) The lack of clarity in defining what ‘smaller domestic or community based wind turbine developments are, and which are seen as suitable, subject to material planning considerations.’
- iii) Coupled with this concern is the potential proliferation of windfarms in a sensitive landscape heavily dependent on tourism, particularly in terms of cumulative and concentrated impact around a designated strategic area.

To this end, they say TAN 8 must be amended to provide *clear and unambiguous* guidance on when a proposal is to be considered unsatisfactory. Conwy County Council also expressed concern about the lack of urgency when considering the significant contribution offshore wind farms can make to the 2010 target. The implementation of the scheme for 30 turbines on the Rhyl Flats (approved) has been deferred pending the outcome of further work on the giant Gwynt y Mor proposal, involving approx. 200 turbines, capable of generating 750 MW of electricity. The Assembly does not consider that this scheme will produce electricity before 2010, which is regrettable, given the greater controversy attached to onshore wind developments.

Early in 2006 then, the overall situation regarding wind has changed considerably. On the positive side it is expected that the target of 10% of electricity being generated by renewable sources, which in the main means onshore wind farms, will be reached. The government has admitted however, that by 2010 the UK would only achieve a 14% cut in carbon

dioxide emissions from 1990 levels, instead of the promised 20% reduction. As already indicated a failure to control a boom in road and air transport and a rise in household energy demands, has all contributed to the failure to cut greenhouse gas emissions.

Although the 10% target may be reached, further progress towards the next target has been interrupted, even curtailed, by several previously unforeseen factors. With a change in the public perception of wind farms, obtaining planning permission for new developments has become more difficult in the UK as a whole. In N.Wales a number of proposals have been rejected because of the fear of over-concentration of wind farms in one area. This situation is coupled with the statutory obligations which the Welsh Assembly has to uphold, regarding landscape impact.

The economic and financial gains promised with each development have not materialised, and the number of long term jobs is small compared with original estimates. At the same time a report published by the National Audit Office maintains that wind farm operators are making huge profits as part of the governments environmental policy. The Renewables Obligation scheme is an innovative mechanism which provides support to companies generating renewable energy. However, this system 'represents an expensive means by which to reduce carbon dioxide emissions--at least over the short and medium terms. By 2010 public support for the renewables sector will cost consumers and taxpayers over £1 billion a year-- the bulk of this accounted for by the Renewable Obligation.'(NAO 2005) Reaching the 2010 target will mean costs to the consumer amounting to a rise in energy bills of around 5.7%, on top of

the normal increases brought about by fluctuations in fuel costs.

In the arguments for and against wind power, numerous facts and figures have been put forward in order to convince the general public, most of whom are unaware how their energy needs are generated, unless they live close by a traditional power station or a wind farm. With a total nominal installed capacity of 58 MW, Cefn Croes, Ceredigion, is one of the largest wind farms in Wales and about which it was said 'that it would supply nearly 50% of the electricity needs of Ceredigion and one percent of the needs of Wales.'(NATTA 2002) What is not emphasised, however, is that if the Capacity Factor for the site is 30%, then the annual average output is only $0.3 \times 58 \text{ MW} = \text{approx. } 18\text{MW}$. Two major industrial plants, Anglesey Aluminium and Corus Port Talbot, between them use 370MW, therefore, at best Cefn Croes would only provide 4.8% of the power required by the two plants.

Many of the areas under consideration at the present time as being suitable for wind farms are close to national parks, for example Snowdonia and the Lake District. High, wild and lonely places tend to be technically suitable for wind farms, which explains why so many applications either pending or already determined also involve sites close to Areas of Outstanding Natural Beauty (AONB) or Sites of Special Scientific Interest (SSSI). At the bottom end of the scale, many SSSI can be deregulated if required, whilst there is evidence to suggest that AONB can also be at risk. In mitigation of these problems, figures produced the British Wind Energy Association (BWEA) in 2000, showed that in order to reach the figure of 10% electricity from renewables by 2010, Wales's share of the whole UK

onshore wind power target would be 8%. (BWEA 2000) The number of turbines needed to reach this target would require a land area of 32 sq.kms or 0.15% of the regions total area.

At first glance, this situation would appear to be satisfactory, but in the ensuing five year period from the release of this report, the outlook for Wales has changed considerably. There has been a relaxation of some planning laws and a possible overriding of local authorities by the Assembly Government, all of which has encouraged developers to outline plans for a further large increase in the number and size of wind farms, thus exacerbating the problem of finding suitable sites. The need to fulfil targets beyond 2010 coupled with the realisation on the part of some energy companies that wind energy is a straightforward and lucrative business for which the necessary financial backing can be found all add to the problem. The increasing pressure on companies to find suitable onshore sites can only be alleviated by the construction of *larger offshore wind farms*, even though the initial costs may be higher.

The UK government has outlined a number of sites suitable for very large offshore wind farms, but little progress has been made towards these ambitious projects. Evidence of this can be seen in the lack of progress towards bringing on stream the first of these huge wind farms at Gwynt y Mor (200 turbines@ 3.5MW each), sited many kilometres of the N.Wales coast. Even when this site has been granted a consent, it is not expected to be up and running before 2010.

viii) Final conclusions

By the year 2010, the first of the government's target years, it is expected that the demand for energy in the UK will be met by a mixture of energy sources. It should be noted, however, that each of these sources will involve some serious disadvantages.

The Department of Trade and Industry (DTI) has carried out many detailed assessments of the future potential for different renewable energy technologies. UK electricity demands in 2001 was 340TWh, of which only 1TWh was supplied by wind power. Currently the UK government has set a target of a 10% contribution from renewable electricity sources by 2010. Since large scale hydro power is considered fully developed, the main burden would fall on wind power, which would be expected to produce in the region of 34TWh. This fraction would in all probability be higher, since overall energy demands would have increased nine years on.

As part of another assessment in 1998 the DTI produced estimates of renewable energy resources in the UK for the year 2025. (Boyle 2004) Even though at the time there was a tendency to overestimate the potential for wind energy in any future programmes, the figures showed that allowing for a number of constraints, *onshore* wind would only produce 8TWh per yr. i.e. around 2.9% of the then total yearly output.

At the same time the outlook for *offshore* wind energy was much more encouraging, with a practical potential of 100TWh per yr. by 2025. This would suggest that until other forms of renewable energy e.g. wave, solar, are sufficiently developed to contribute to the overall energy requirements, then offshore energy would be the major source. However, as previously

outlined, wind energy although ideal in many ways, cannot be relied on to supply a constant fixed amount of energy and must be backed up by more conventional sources.

With the exception of a small number of very large units (e.g. Drax) most of the traditional coal fired stations will have disappeared but plans for a 460MW “clean energy” power station near Onllwyn in the Dulais Valley, South Wales have been outlined. This IGCCT (Integrated Gasification Combined Cycle Turbine) powered power station is expected to use locally-produced coal and would hope to go some way towards meeting stringent environmental controls in that it is able to capture and store carbon dioxide and at the same time produce hydrogen. Even at its best, however, this system will only capture about 70% of carbon dioxide emissions and it will be very expensive. If this system is approved and if government support and finance is available, coal fired IGCCT stations could play a significant part in meeting future energy demands and in the development of an emerging hydrogen market-- seen as a “green fuel” in the future.

Despite being seen as a possible solution to the difficulties found in other energy sources, there are no plans for future large scale hydro electric power stations and although wave power and tidal barrages are both proven sources of alternative energy, little has been done to finance and implement either of these. Even in the event of a definitive decision to go ahead with a major project, it will take many years to bring to fruition and finance may not be available. As a prime example of this dilemma, renewed interest has been shown in the Severn tidal barrage. In another

round of energy reviews by the UK government, a £10billion, 10 mile-long barrage is among options for future energy provision recommended by the Welsh Assembly Government. It is said that the scheme could provide as much energy as two nuclear power stations for up to 150 years. A number of sites throughout the world where high tides could be harnessed have been previously examined but, with one exception, all of these have been rejected on the grounds of high capital costs of structures partly submerged in salt water and the problem of silt flows. The one major exception, the French Rance tidal plant at St. Malo generates 240MW of electricity, or roughly one third of the proposed wind farm at Gwynt y Mor. This plant has been running for more than 30 years, yet despite the apparent success of this form of energy, the French have not repeated the experiment and now rely heavily on nuclear power.

Although the Department of Trade and Industry (DTI) is to end the government's 2002--2012 Solar Photovoltaic Programme, the PV programme will be subsumed into a wider Building Integrated Renewables programme. The technology is becoming less expensive and could, in many cases, generate most of a house's demand for electricity, always provided the government legislates for solar panels to be provided in all new buildings and grants allowed for installation in older properties as is the case with insulation.

Figures compiled by the Office for National Statistics showed that in 2002, natural gas provided 32% of the total fuel bill used in generating electricity in the UK. (National Statistics 2004). With the removal of most of the coal fired power stations and the uncertainty surrounding nuclear power, any

sudden demand for power at certain times of the year may have to be met by gas powered generators. However, gas supplies from British owned platforms in the North Sea will soon begin to run out, so the construction of a new liquified gas plant at Milford Haven in S.Wales to receive gas tankers from abroad can be seen as a major step forward. At the same time it should be noted that these supplies will be imported from politically unstable countries, including some in the Middle East and Russia.

When this gas terminal is commissioned, plans have also been outlined for one or possibly two large gas fired power stations in the area around Milford Haven. This would make sense, as gas supply lines would be kept to a minimum, much in the same way that many coal fired stations were built adjacent to working coal mines. Given the urgency surrounding the continuity of gas supplies, work on building the adjacent power stations could begin in the next few years, as opposed to decades required to bring on line new nuclear stations or wave power systems. The problems usually associated with finding suitable sites and obtaining planning permission would be considerable less, as a number of brown field sites, once part of the now defunct iron and steel industry, are available. Unlike some of the estimates put forward for the number of jobs generated by future wind farm developments, this project would certainly provide a large number of well paid and skilled manufacturing and construction jobs in an area with an above average unemployment rate.

This then leaves the energy industry with the problem of nuclear energy. By 2015 this form of energy will represent only a very small fraction of the total supply. The decision, to either completely remove nuclear power

in its present form, or to move on to the next, improved, safer and more cost effective version, must be made in the next few years. Although there are major problems with waste fuel disposal, it is environmentally friendly in that there are no direct carbon dioxide emissions, it is not reliant on imported fuel to the same extent as gas is and provides constant all the year round energy. The government, in seeking the best possible long term solution have indicated, on numerous occasions, that nuclear energy will play an essential part in any long term energy plan. However, even if a decision is made to continue with nuclear energy, the very large sums of money involved, the inevitable delays in reaching satisfactory planning decisions and the long lead time needed to build and commission new power stations will mitigate against it being a major source of energy before 2020.

When considering the future of the nuclear industry the Energy White Paper of Feb. 2003 did not rule it out, but came down firmly in favour of energy efficiency and renewables being given priority as the best option for the UK's future energy needs. Every government white paper has contained manifesto commitments to reduce carbon dioxide emissions by increasing amounts. The original commitment of approximately 10% by 2010 previously mentioned, has been upgraded to include a voluntary unilateral carbon dioxide reduction target of 20% by 2020, although the latter has been seen as overly ambitious and unlikely to be met.

In order to reach these targets (set in 2003), nuclear energy was not ruled out forever but put on hold for at least 5 years, but recent changes (2005) in the energy situation have seen this form of energy being likely to be

reinstated. Advanced designs of nuclear reactors are being developed--where finance is available--but nuclear power remains expensive to build and could take a decade or more to find appropriate sites and get the necessary planning permission. However, the government in the person of the Prime Minister, takes the pragmatic view that 'there was no way nuclear power could be removed from the agenda if you are serious about the issue of climate change'. (The Guardian July 7th 2004)

Thus by the year 2015 and well beyond, the increase in energy demand forecast for the UK will be met in the main, by two sources, gas and renewables, both unreliable in a number of ways. Large *offshore* wind farms will make a significant impact on the UK's future energy demands, but only as part of a scenario which includes other forms of energy generation. The government's preoccupation with reaching arbitrary targets as opposed to legislating for genuine achievements, has led to a crisis in the energy industry. Without a sustained reduction in energy use coupled with a higher government priority for improvements in energy efficiency, any reduction in emission levels will become increasingly difficult. Overall greenhouse gas emissions including carbon dioxide have started to rise again after a promising fall in the late 1990s. The current round of statistics show it is unlikely that the government's promise of cutting emissions by 20% between 1990 and 2010-- the main 'raison d'être' for encouraging renewable energy-- will be met. The majority of the earlier falls in greenhouse gas emissions were due to the switch from coal to gas by the electricity generation industry and equally as important, falling emissions from the UK's declining manufacturing base. However,

the underlying trend is now in reverse, with electricity generators, which contribute around a quarter of all emissions, releasing 6.3% more greenhouse gases between 2002 and 2003. In addition to this there has been a steep rise in emissions from the transport and communications sector --- especially aviation which was not included in the Kyoto agreement-- and a steep rise in total energy consumption since 1990.

In a final assessment of the future of renewable energy, it is necessary to point out that the dilemma about the way forward for future energy generation and demand in the UK cannot be separated from other major problems which will arise in the early part of the 21st century--- it is an integral part.

The problems of a population approaching 60 million.--only Holland in Europe has a greater density of population per sq. mile.-- will impinge on all sections of life. One such problem is the government's plan to build up to 500,000 new homes by 2021, mainly in the SE of the country. Despite the trend towards smaller household size the construction of such a large number of houses will obviously place a new burden on energy demands, especially if new houses do not include radical new designs for energy saving. Any increase in population will also result in an increase in vehicles which in turn will lead to a further rise in carbon dioxide levels.

As well as increased pollution levels, housing plans of this magnitude will lead to other problems, especially in terms of the demand for water-- already a major problem in the SE. Those areas of the country already experiencing problems with the expansion of onshore wind farms and where wind often equates with high rainfall levels, may well be needed to

provide large tracts of land for water storage which can then be piped to the south. This situation is not a new one: historically Wales and the Lake District have seen large areas taken over for huge reservoirs and lakes to provide water for Birmingham, Manchester and Sheffield but any further encroachment into these parts of the country will meet with stiff resistance. Many of the areas under consideration are either heavily wooded or the nature of the land is such that they are seen as a means of trapping large amounts of carbon dioxide. This would help to counterbalance the inevitable rise in pollution levels brought about by increased housing and transport levels.

There are signs at the end of 2006, that the energy industry, committed to reducing carbon dioxide levels by 2010 as part of a government initiative, will face significant problems in deciding how best this can be achieved. Problems encountered with the “preferred” methods of energy generation may well lead the government to look in a new light at those methods in use at the present time.

Major fluctuations in both the supply and cost of oil and gas, coupled with increased global demands on what, in the long term, is a finite source of energy, may well require a change in direction by the government. Much has been made of the move towards green energy, but the government’s public accounts committee have shown that the “renewables obligation” did not represent value for money. Where electricity suppliers have been ordered to obtain a growing percentage of their energy needs from renewable sources each year, this bounty has provided energy generators with extra funds to invest in wind farms and other sources of renewable

power. Unfortunately electricity companies will, almost inevitably, pass on these higher costs to the consumers, to the extent that they will be expected to pay an extra £5 billion between now (2006) and 2010. It is no coincidence that a number of major energy suppliers have attracted hostile bids from French, Russian and German energy companies --there will be a lot of money to made, all at the expense of the consumers.

In Wales, the Assembly Government's TAN 8 document, approved in July 2005 despite widespread opposition, threatens a revolution in the Welsh landscape. Development in the 7 Strategic Search Areas will be bitterly opposed, whilst at the same time, plans for 200 offshore turbines -- the obvious solution for Wales-- have developed at a much slower pace.

In England, because of rising electricity prices and the uncertainty surrounding renewable energy, a 4000MW coal- fired power station located in Yorkshire owned by the Drax Group has been saved from bankruptcy by a £1.9 billion cash takeover bid by an American power group. The size of this power station -- equivalent to approx. 70 North Hoyle wind farms-- and the interest in saving a coal-fired station which is considered a 'dirty' means of generating electricity-- is an indicator of both the problems facing the energy industry over the next 10 years, and the expectations that a considerable amount of money can be made over the same period. At the same time there is a proposal to extend the life of the Dungeness 'B' nuclear station by a further 10 years, thus allowing time for the government to make a decision on the future of nuclear energy.

Despite the seeming lack of urgency in implementing the targets set by

the government and the difficulties incurred in reaching any positive outcomes, it is not impossible that renewables in their present form i.e. wind power, are capable of providing a significant proportion of the energy required by electricity consumers.

However, until other forms of renewable energy come on stream, in many years from now, the government must make a decision in the immediate future as to which form of energy will provide the bulk of the country's energy needs. Inadequate attempts at energy saving and the talk of a "mixed" energy industry will not produce the required achievements. Despite numerous government reports, 'white' papers and consultations, the constant prevarication over which route to take has made the problem increasingly more difficult and equally more expensive.

Appendix 1

The difficulties and contradictions associated with planning applications for wind farms, are well illustrated in the following two examples. (Examples 1&2) Many of the arguments for and against any proposed wind farm can be seen in these two examples. These include :-

- i) The issue of visual impact.
- ii) Community wind farms.
- iii) The distribution of any profits accruing from electrical generation.
- iv) The motives behind privately owned wind farms.
- v) Applications to increase the size of older, established wind farms.
- vi) The idea that community wind farms will result in cheaper electricity for the local population.

It can also be seen that the subject of the 7 strategic search areas (SSAs) outlined in Tan 8 will become one of the most important factors in any future plans. If, as seems likely, there will be a concentration of turbines within these areas, then this in itself will give rise to further objections -- “the industrialisation of the landscape.” This much is obvious from the comment that ‘there are already 56 turbines on Carno wind farm so another 12 turbines is not a big issue.’(Western Mail 2006)

Farmers given go-ahead for one of the first privately owned wind farms in Wales –
Western Mail, Wednesday, 23 August 2006

WIND power means Si n Thomas does not have to abandon his family farm but instead can use the land and a limitless natural resource to generate a new source of income. Wind farms across Wales have had many opponents, but Mr Thomas is a fan of the new technology which has unlocked a new source of livelihood. He is now spearheading a £15m independent wind farm development near his home in Carno, Powys. The family's 600-acre beef and sheep farm supports his parents and two brothers. Mr Thomas realised it could not economically sustain another member of the family and began looking for a new means to earn a living. He said, "I had to look elsewhere and decided to diversify and worked in the wind farm sector which provides well-paid, skilled employment. The industry invests in its people and provides high quality jobs and employs about 100 people in Mid Wales. If it hadn't been for this then I would have had to leave Mid Wales to find work elsewhere."

He works in partnership with his father Gwyndaf and neighbour David Richards and they now have the go-ahead to construct a 12-turbine wind farm. It will be one of the first privately owned wind farms in Wales. It will be a neighbour of the existing npower Renewables 56-turbine Carno wind farm, part of which is based on the Thomases' Bronhaul Farm. Mr Thomas's new company is named Amgeni. It translates from the Welsh "for energy" and is supported by the Assembly Government's Energy office. The office provided advice and funding for feasibility studies and the Mid Wales Energy Agency and Finance Wales provided a loan. A milestone was reached last month when planning permission was unanimously approved by Powys County Council. Mr Thomas said this was "a considerable relief" because they had already invested a significant amount of money securing grid capacity prior to obtaining planning consent. The next stage is ensuring all the finance is secured before Amgeni embarks on actually building the wind farm. He expects it will create between 30 and 40 jobs during the construction phase.

The farm will provide 15.6 megawatts of power which will be fed into the local distribution network, meeting the electricity needs of approximately 9,500 homes. An Assembly Government spokeswoman said, "What differentiates this wind farm development from most others is that it is a locally owned project, developed by local families and fully supported by the local communities." Mr Thomas said, "The support from the community has been incredible. Local people are familiar with wind farms - they can see the direct benefits they bring and know that the myths that the turbines are noisy or can cause property prices to plummet are untrue." He added, "I think a lot of people are afraid of the unknown. But there are already 56 turbines on Carno wind farm so another 12 turbines is not a big issue. "During the consultation process over 160 local people actually wrote in supporting the project but some 60 letters were received opposing it, the majority from people who weren't even living in Wales - some wrote in from as far as London and Oxford, which is rather bizarre."

Once operational, Amgeni will become a source of funds for Windfall – the Mid Wales Community Energy Trust, which is managed by Mid Wales Energy Agency. Windfall collects a proportion of the revenue from green energy generation projects in Mid Wales and redistributes it among local communities. The money is offered as grants for energy efficiency and renewable energy projects to communities, householders, farmers, schools and businesses. To date, the communities of Carno, Caersws and Trefeglwys have benefited from funding secured this way from npower Renewables and Entrust. It has been invested in energy saving and renewable energy systems such as solar water heating, wood energy and photovoltaics. When Amgeni starts generating it will donate £10,000 annually to Carno and Llanbrynmair communities and in the fourth year will donate a further £20,000 annually to the Mid Wales Community Energy Trust.

David Williamson, Western Mail

EXAMPLE 1 DETAILS OF A PLANNING APPLICATION FOR A
WIND FARM AT CARNO, POWYS WHICH WAS GRANTED

(WESTERN MAIL 23RD. AUG 2006)

Inquiry upholds windfarm refusal

Backers of a community wind farm in the upper Swansea Valley have lost their appeal against planning refusal.

The Planning Inspectorate has upheld Neath Port Talbot Council's decision not to grant Awel Aman Tawe permission for three turbines on Mynydd y Gwrhyd.



Awel Aman Tawe said the windfarm would fund regeneration

It was turned down by council planners because of its likely visual impact.

Following a public inquiry earlier in the year inspectors backed the decision, a move welcomed by Labour Neath AM Gwenda Thomas.

"My main concerns were the overbearing visual impact on both Tai'rwaith and Rhiwfawr and the fact that the wind farm would have been outside the TAN 8 strategic search area (SSA)," she said.

There are seven SSAs in Wales chosen by the Welsh Assembly Government as recommended locations for turbines.

Awel Aman Tawe had said profits from the sale of electricity generated by the turbines would be used to fund local regeneration initiatives.

The community group had claimed that of 13,000 local residents in 14 villages surrounding the site there was a "clear majority in favour of the project" in a referendum on the scheme.

**EXAMPLE 2 DETAILS OF A PLANNING APPLICATION ON
BEHALF OF AWEL AMAN Tawe FOR A WIND FARM ON
MYNYDD Y GWRHYD, SWANSEA WHICH WAS REFUSED
(BBC NEWS 2ND. OCT. 2006)**

Appendix 2

Figures obtained from the MetOffice, for wind speeds in Scotland and Wales over a period of 12 days in December 2006 (Tables 8&9) clearly show that the likelihood of low wind speeds affecting the whole of the UK is not a 'rare event'. Throughout this period only on one or two days did wind speeds approach that required to produce maximum power output. Even those weather stations situated in very exposed positions (Lerwick & Stornoway) only registered wind speeds of over 25 knots twice and the rest, including those in Wales, were well below the *rated power* requirement for a wind turbine.

These low wind speeds occurred during a period of high barometric pressure developing over an already saturated ground, resulting in cold, damp and foggy weather (not unusual for this time of the year) right through the period up to, and including, Christmas. Any obvious rise in electricity demands could not have been met by the seriously under powered wind farms and existing power stations would be put under severe pressure to make up the difference.

During late November and early December, 2006, and January 2007, the opposite situation arose, with strong gale force winds throughout the UK resulting in turbines having to be shut down. This shows that on occasions, even the diversification of wind power sites throughout the UK is not sufficient to maintain a constant energy demand throughout the year. (Tables 10 & 11)

WEATHER STATIONS IN WALES

Aberporth	13	3	5	5	5	3	6	6	8	7	21	12
Lake Vyrnwy	9	n/a	n/a	n/a	n/a	n/a	n/a	2	2	n/a	n/a	5
St. Athan	8	6	4	4	1	4	8	9	9	7	8	5
Sennybridge	n/a	2	1	2	n/a	n/a	3	9	4	n/a	n/a	n/a
Trawscoed	8	5	n/a	n/a	n/a	n/a	3	6	n/a	n/a	12	2
Valley	8	5	n/a	3	12	6	5	2	6	8	15	20

17 18 19 20 21 22 23 24 25 26 27 28

DECEMBER 2006

TABLE.8 WIND SPEEDS (KNOTS) OVER A PERIOD OF 12 DAYS.

Numbers show wind speeds for each station @ 12.00 GMT each day

WEATHER STATIONS IN SCOTLAND

Aberdeen	8	1	7	3	3	3	n/a	3	1	3	2	1
Aboyne	6	6	n/a	5	10	n/a	n/a	n/a	n/a	3	n/a	3
Avimore	n/a	n/a	6	5	18	7	8	1	7	1	1	1
Edinburgh	7	1	11	12	15	7	10	3	9	n/a	n/a	3
Eskdalemuir	7	3	2	4	8	3	4	2	5	4	n/a	2
Glasgow	3	4	1	4	7	4	6	2	2	1	2	3
Kinloss	7	2	11	6	17	3	8	1	7	4	2	2
Kirkwall	2	8	22	n/a	18	11	15	6	6	8	7	8
Lerwick	8	11	31	22	16	19	26	7	12	13	6	9
Leuchars	9	3	11	8	14	11	9	2	6	n/a	3	3
Loch Glascarnoc	n/a	n/a	9	n/a	21	n/a	12	n/a	4	n/a	n/a	6
Lossiemouth	8	5	8	9	8	12	9	3	9	3	1	9
Machrihanish	7	2	7	5	10	3	4	11	7	12	15	11
Skye Lusa	5	n/a	7	8	13	12	6	6	7	6	3	2
Stornoway	5	3	10	14	29	17	16	15	17	5	15	3
Tiree	6	9	11	13	21	12	15	18	16	9	23	24
Tulloch Bridge	n/a	n/a	4	1	8	10	n/a	n/a	6	n/a	5	5
Wick	6	3	10	5	12	11	10	3	4	6	4	6

17 18 19 20 21 22 23 24 25 26 27 28
DECEMBER 2006

TABLE 9. WIND SPEEDS (KNOTS) OVER A PERIOD OF 12 DAYS

Numbers show wind speeds for each station @ 12.00 GMT each day

WEATHER STATIONS IN WALES

Aberporth	23	13	14	24	15	n/a	31	21	36	22	18	27	25	23
Lake Vyrnwy	19	18	17	16	6	17	25	n/a	25	22	19	26	25	30
St Athan	11	12	n/a	n/a	n/a	12	26	23	32	16	9	18	22	16
Sennybridge	23	14	18	26	n/a	17	23	n/a	n/a	20	3	20	n/a	25
Trawscoed	14	7	8	19	n/a	5	15	n/a	13	11	11	10	14	11
Valley	37	20	19	37	14	27	40	27	32	37	19	28	37	31
	27	28	29	30	1	2	3	5	7	10	11	12	13	14
	NOVEMBER						DECEMBER 2006							

TABLE 10 .WIND SPEEDS (KNOTS) OVER A PERIOD OF18 DAYS

Numbers show wind speeds for each station @ 12.00 GMT each day.

* Numbers in red show where wind *gusts* of over 49 knots (56 mph) also occurred which would result in a turbine reaching cut-off speed. *

WEATHER STATIONS IN SCOTLAND

Aberdeen	24	17	21	15	6	21	23	10	13	22	17	21	16	14
Aboyne	7	6	8	12	8	10	8	14	7	11	6	20	6	12
Aviemore	12	13	7	23	10	15	20	12	7	17	7	30	13	13
Edinburgh	12	8	16	21	9	13	24	11	11	26	14	19	23	13
Eskdalemuir	12	9	12	17	9	17	15	8	14	24	10	14	20	9
Glasgow	9	8	16	23	11	17	n/a	8	14	27	21	20	22	7
Kinloss	17	11	13	21	11	5	16	13	3	18	15	15	5	11
Kirkwall	22	11	22	18	19	12	24	13	4	25	21	22	13	32
Lerwick	22	17	28	33	27	27	26	3	18	39	27	26	12	41
Leuchars	7	21	23	23	9	16	15	11	13	25	18	17	22	21
Loch Glasc.	15	7	16	n/a	12	2	11	9	6	24	22	25	6	26
Lossiemouth	12	12	18	18	16	11	15	7	5	28	22	18	10	17
Machrihanish	24	19	21	29	11	22	27	10	17	25	26	31	24	18
Skye Lusa	10	13	23	19	7	9	8	13	6	15	24	19	25	25
Stornoway	20	26	24	40	14	18	24	18	14	21	24	24	18	23
Tiree	30	23	n/a	n/a	n/a	22	20	15	8	25	28	28	34	20
Tulloch Brid.	12	9	17	18	7	11	10	10	5	15	11	17	21	12
Wick	19	9	18	26	9	15	26	10	5	26	17	24	17	25
	27	28	29	30	1	2	3	5	7	10	11	12	13	14
	NOVEMBER							DECEMBER 2006						

TABLE 11. WIND SPEED (KNOTS) OVER A PERIOD OF 18 DAYS

Numbers show wind speeds for each station @ 12.00 GMT each day

* Numbers in red show where wind *gusts* of over 49 knots (56 mph) also occurred which would result in a turbine reaching cut-off speed.*

REFERENCES

Asmus, P (2001) 'Reaping the Wind : How Mechanical Wizards, Visionaries and Profiteers helped shape our energy future.' Island Press, Washington D.C. & Covelo, California.

Bibbings (2004), Bibbings, J Climate Concern -- 'Attitudes to Climate Change and Wind farms in Wales.' Welsh Consumer Council & Friends of the Earth Cymru. pp. 1-7 September 2004.

Blandford(1994), Blandford, C 'Can we learn to love the wind.' Focus New Scientist pp. 12-14 16th July 1994.

Boyle, G & Everett, R (2004) Chapter 10 'Integration' in Boyle, G (ed.) 'Renewable Energy: Power for a Sustainable Future.' 2nd Ed. Oxford University Press, Oxford, in assoc. with the Open University.

BWEA (2000), ' Report from the 22nd Annual Conference.' p. 3 6th-8th Sept. 2000.

BWEA (2004), 'BWEA Representation : Draft TAN 8 Consultation.' British Wind Energy Association pp. 1-8 November 2004.

Carbon Trust (2004) The Carbon Trust and DTI Renewable Networks Impact Study.

CCBC (2002), 'An environmental strategy and action plan for the Hiraethog area --Consultation Draft' Conway County Borough Council pp. 1-24 February 2002.

CCW (1998) -- Reference to Environment Act 1995 -- Countryside Council for Wales.

COWL NEWS (2002), 'Cowl-- a new name in green energy for Wales Rhyl Flats Offshore Wind Farm.' Issue No. 1 March 2002.

CPRW (1998), Council for the Protection of Rural Wales. Letter to Director of Planning, Conway County Council 'The flawed depiction of landscape and of visual impact at Pentrefoelas Wind Power Station.' 12th June 1998.

Daily Telegraph (2004) 18th October 2004.

Daily Post (2002) 24th May 2002.

Daily Post (2004) Business News January 17th 2004.

Dale et al. (2003), 'A shift to wind is not unfeasible (Total Cost Estimates for Large- Scale Wind Scenarios in UK)' Power UK, Issue 109 pp.17-25

Damborg (1998), Damborg, S 'Public attitudes towards wind power.' Danish Wind Industry Association pp. 1-9 Article updated 6th June 2002.

Devine-Wright (2004), Devine-Wright, P 'Beyond NIMBYism: toward an Integrated Framework for Understanding Public Perception of Wind Energy.' Research article : WIND ENERGY John Wiley & Sons Ltd pp. 1-15 26th June 2004.

Devine-Wright et al (2006), Devine-Wright, P and Devine-Wright, H 'Social Representations of Intermittancy and the Shaping of Public Support for Wind Energy in the UK' Int. J. Global Issues Vol. 25, Nos. 3/4, 2006.

DTI (2001), DTI 'Wind Energy Fact Sheet 14: Efficiency and Performance.' Department of Trade and Industry -- Sustainable Energy Programme pp. 1-5 HMSO August 2001.

DTI (2002) 'Digest of UK Energy Statistics for 2001' (DUKES) Dept. of Trade & Industry HMSO 2002.

DTI (2003), 'Our Energy Future--Creating a Low Carbon Economy' Dept. of Trade & Industry HMSO 24th Feb. 2003.

DTI (2003), 'Government delivery of biggest ever expansion of renewable energy.' p.1 P/ 2003/ 618 Dept. of Trade & Industry 18th HMSO Dec. 2003.

DTI (2006), 'Government and public support for renewables remains strong' Industry Conference -- Malcolm Wicks 24th May 2006

DTI (2006), Energy Review Report 'The Energy Challenge' Dept. of Trade & Industry HMSO July 2006.

East & Wright (2003), East, R & Wright, M 'White Papers and Fighting Talk.' Green Futures Issue 39 p. 5 March / April 2003.

EDC (2002), EDC, 'A Review of Energy Policy in Wales, Part 1: Renewable Energy' Economic Development Committee -- Report for Consultation in National Assembly for Wales April 2002.

EDC (2003), EDC, 'Review of Energy Policy in Wales: Renewable Energy--Final Report' Economic Development Committee--National Assembly for Wales January 2003.

Elliott (2001), Elliott, D 'Wind Power in the UK --the need for a fresh start' Abstract from Draft for WEC e- conference pp. 1-7 May 2001.

Ellis, G, Barry, J and Robinson, C (2006) 'Many ways to say "No"- Different ways to say "Yes": Applying Q- Methodology to understand public acceptance of wind farm proposals.' Queen's University, Belfast. ESRC, Economic & Social Research Council.

E.ON (2004), Wind Report 2004, Published by E.ON Netz GMBH, Bayreuth, Germany.

Herring (1998), Herring, H 'Does Energy Efficiency Save Energy: The Economists Debate'. Milton Keynes: The Open University.

Hinshelwood & McCallum (2001), Hinshelwood,E, & McAllum,D, 'Examining approaches to Renewables Consultation-- Lessons from Awel Aman Tawe Community Wind Farm Project.' DTI Sustainable Energy Programme pp. 1--117 HMSO 2001.

ICCEPT (2002), 'Assessment of Technological Options to Address Climate Change : A Report for the Prime Minister's Strategy Unit' Imperial College Centre for Energy Policy & Technology 20th Dec.

IEA (1998), IEA'Review of the Environmental Statement for Pentrefoelas Wind Farm.'Appendix 9 Institute of Environmental Assessment, Welton House, Lime Kiln Way, Lincoln pp. 1 -12 . 1998.

IPCC (2001), IPCC , 'Climate Change 2001: the Scientific Basis.' Intergovernmental Panel on Climate Change. Cambridge Univ. Press

Ipsos (2003) Opinion Poll Survey of Householders' Opinions on Wind Energy Development, Survey commissioned by British Wind Energy Association.

Krohn (2002), Krohn, S. 'Offshore Wind Energy : Full speed ahead.' Danish Wind Industry Association pp. 1-14 October 2002.

National Assembly for Wales (2005), ' Press Release : 90 New Special Areas of Conservation in Wales under EC Habitats Directive' pp. 1-6 January 2005.

National Audit Office (2005), 'Renewable Energy' Dept. of Trade & Industry- Report by the Comptroller & Auditor General pp. 1-7 HMSO - London 7th. February 2005.

NATTA (2001), 'UK Planning Battles' News and Developments from RENEW 134 Network for Alternative Technology and Technology Assessment, Milton Keynes p. 6, 2001.

NATTA (2002), 'Wind Battles in Wales.' Introduction from RENEW Vol.V Network for Alternative Technology & Technology Assessment, Milton Keynes p. 8 Nov. 99 to May 2002.

NATTA (2005), 'Wind Rush' News and Developments from RENEW No. 154 Network for Alternative Technology & Technology Assessment, Milton Keynes p.6 Mar/ Apr. 2005.

NATTA (2005), 'UK Renewables so far...' News and Development from RENEW No. 158 Network for Alternative Technology & Technology Assessment, Milton Keynes p. 3 Nov/ Dec 2005.

NWP (1998), NWP 'Letter to Snowdonia National Park Authority re Pentrefoelas WindFarm-Planning Consultation.' National Wind Power, Bourne End , Bucks pp. 1-4 4th August 1998.

NWWN (2002) North Wales Weekly News July 25th 2002.

ONS (2004), Table 22.10 'Electricity: fuel used in generation for UK.' Office for National Statistics : Annual Abstract of Statistics No. 140 2004 Ed. London TSO.

Oswald et al (2006) Oswald,J. Raine,M. Ashraf-Ball, H. & Murphy, E. 'UK Wind Farm Performance 2005, based on Ofgem ROC Data' Oswald Consultancy Ltd.

OXERA (2003) 'The Non-Market Values of Generation Technologies' Oxford, June

Pasqualetti, M J. (2000) 'Morality, Space, and the Power of Wind-Energy Landscapes' The Geographical Review July 2000, Vol. 90 pp. 381-394

PIU (2002), PIU, ' The Energy Review' A Performance & Innovation Unit Report HMSO, 14th Feb. 2002.

RCEP (2000), RCEP, 22nd Report 'Energy-- the Changing Climate'
Royal Commission on Environmental Pollution, HMSO 16th June 2000

Sharman, H. (2002) 'The Practicalities of Developing Renewable Energy in the UK--In the Light of Danish Experience,' Incoteco (Denmark) ApS.

Simpson (2004), Simpson,D. 'Tilting at windmills: The economics of wind power' Hume Occasional Paper No. 65 The David Hume Institute April 2004.

Sinclair (2003), Sinclair, G. ' The Myth has Exploded.' Council for the Protection of Rural Wales.' (CPRW) Cymru Wledig - Rural Wales pp. 18-19 Spring 2003.

Sinden (2005), Sinden, G 'Wind power and the UK wind resource' Environmental Change Institute, Oxford University Centre for the Environment

Smil,V (2003) Energy at the crossroads: global perspectives and uncertainties. MIT Press, Cambridge, Massachusetts.

SNPA (1998), SNPA 'Letter to Conway County Borough Council re Proposed Wind Farm at Pentrefoelas, Denbigh Moors.' Snowdonia National Park Authority pp. 1-4 27th July 1998

SDC, (2005) Sustainable Development Commision. 'Wind Power in the UK.'

Taylor, D (2004) Chapter 7 'Wind Energy' in Boyle,G (ed.) 'Renewable Energy: Power for a Sustainable Future.' 2nd Ed. Oxford University Press, Oxford, in assoc. with the Open University.

Toke, D. (2005) 'Explaining wind power planning outcomes: Some findings from a study in England and Wales.' Energy Policy Vol. 33 pp. 1527-1539

UKERC (2006), 'The Costs and Impacts of Intermittency'

An assessment of the evidence on the costs and impacts of intermittent generation on the British electricity network.

UK Energy Research Centre. March 2006 Imperial College London.

Walker, G. (1995) 'Renewable Energy and the Public.' Land Use Policy Vol. 12 pp. 49-59.

Warren et al (2005) Warren,CR., Lumsden,C., O'Dowd,S., Birnie, RV. 'Green on Green' : Public Perceptions of Wind Power in Scotland & Ireland. Journal of Environmental Planning & Management Vol. 48, No 6, 853- 875, November 2005.

Welsh Office (1996) 'Planning Guidance (Wales) Technical Advice Note (Wales) 8--Renewable Energy' Annex A p. 8 November 1996

Welsh Office (2004), 'Consultation Draft -- Planning Policy for Wales. Draft Technical Advice Note 8-- Renewable Energy' Supplement to Planning Policy Wales. (March 2002)

Welsh Office (2005) 'Revised Technical AdviceNote 8--Renewable Energy.' July 2005

Wolsink (2000) Wolsink, M. 'Wind power and the NIMBY-myth: institutional capacity and the limited significance of public support.' Renewable Energy Vol. 21 pa. 49-64 2000 Pergamon Press.

TABLES AND DIAGRAMS

Figure 1 Typical wind turbine power curve, showing how the power output varies with wind speed. (DTI wind energy fact sheet 14, 2001)	Page 70
Map 1 Location of weather stations throughout the United Kingdom. (MET. OFFICE 2006)	Page 74
Table 1 Mean monthly wind speed averages for 'exposed' sites in Scotland.1971-2000 (MET. OFFICE 2006)	Page 75
Table 2 Mean monthly wind speed averages for 'exposed' sites in Wales. 1971-2000 (MET. OFFICE 2006)	Page 76
Map 2 Round One and Two Wind Farm Sites. (THE CROWN ESTATE June 2004)	Page 79
Table 3 Mean monthly wind speed averages for two 'distant' inland sites. 1971-2000 (MET. OFFICE 2006)	Page 81
Table 4 Conversion of wind speed to power output for a 2,500 kW wind turbine. (ENVIRONMENTAL CHANGE INST. 2005)	Page 82
Table 5 Major wind farms either 'live' or 'under construction' in Scotland and Wales by the end of 2005 in relation to the nearest weather station. (BWEA 2005)	Page 84
Table 6 Wind speeds in knots over a period of 11 days in Wales 2006. (MET. OFFICE 2006)	Page 85
Table 7 Wind speeds in knots over a period of 11 days in Scotland 2006. (MET. OFFICE 2006)	Page 86

- Fig. 2 The contribution of wind power during 2003 in E.ON control area showing fluctuations. (E.ON 2004) Page 91
- Fig. 3 Wind power infeed 2003 in the E.ON control area. (E.ON 2004) Page 91
- Fig 4 Fluctuations in wind power infeed over a period of 4 days in the E.ON control area. (E.ON 2004) Page 93
- Fig 5 Effect of rapid decrease in wind power infeed over a 6 hour period in the E.ON control area. (E.ON 2004) Page 93
- Map 3 Areas of conservation and natural beauty in Wales. (CROWN COPYRIGHT 2003) Page 152
- Map 4 Map showing strategic search areas for onshore wind power in Wales. (WELSH ASSEMBLY GOVERNMENT OFFICE) Page 161
- Map 5 Mean annual capacity factors for UK wind farms in each region 2005 and 2006. (OSWALD et al 2006) Page 180
- Example 1 Details of a planning application for a wind farm at Carno, Powys which was granted (WESTERN MAIL 23rd Aug. 2006) Page 200
- Example 2 Details of a planning application on behalf of Awel Aman Tawe for a wind farm on Mynydd y Gwrhyd, Swansea which was refused. (BBC NEWS 2nd Oct. 2006) Page 201

Table 8 Wind speeds (knots) over a period of 12 days in Wales. 2006 (MET. OFFICE 2006)	Page 203
Table 9 Wind speeds (knots) over a period of 12 days in Scotland. 2006 (MET.OFFICE 2006)	Page 204
Table10 Wind speeds (knots) over a period of 18 days in Wales. 2006 (MET.OFFICE 2006)	Page 205
Table11 Wind speeds (knots) over a period of 18 days in Scotland. 2006 (MET.OFFICE 2006)	Page 206